X-4711

MAINTENANCE MANUAL AND SUPPLEMENT

GM COACH

MODEL PD-3751

GMC TRUCK & COACH DIVISION

GENERAL MOTORS CORPORATION

X-4711

MAINTENANCE MANUAL

GM GENERAL MOTORS COACH

MODEL

PD-3751

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GENERAL MOTORS CORPORATION
PONTIAC, MICHIGAN

PRINTED IN U.S.A. TECHNICAL PUBLICATIONS — 3M — JUNE 1947

QUICK REFERENCE GROUP INDEX

The first page of each group or section of a group has a black tab bearing group letter or number. These tabs are in same relative positions as shown on this page.

READ PAGE 5 BEFORE USING MANUAL

INTRODUCTION

This manual includes complete operation and repair information on Coach Model PD-3751.

The information is conveniently arranged in the manual according to important groups. Each group or section of a group treats with a major unit or system of the vehicle. The procedures containea in each group are recommended for efficient service.

By referring to the various indexes in succeeding pages, important subjects can be readily found in the manual.

GMC TRUCK & COACH DIVISION

GENERAL MOTORS CORPORATION

PONTIAC, MICHIGAN

HOW TO USE THIS MAINTENANCE MANUAL

(READ THIS PAGE BEFORE USING MANUAL)

This manual includes **general data, operation, maintenance,** and **repair** procedures on all important systems and units of GM Coaches for models listed on Page 1. With an understanding of the text arrangement and by reference to the proper index, instructions and data can be readily found.

MANUAL ARRANGEMENT

MAJOR GROUPS—The sections of the manual are numerically arranged in sequence by **Major** groups such as **O. Operation, 1. Front Axle, 2. Rear Axle,** etc. The manual location of each group or section can be quickly found by referring to the **"Quick Reference Group Index."** A black tab bearing the major group number is placed on the first page of each section in relatively the same location as like tabs on page 3.

SECTIONS—Many of the major groups are divided into separate sections, each section including specific information on units or important phases of the group. As an example:

The **Brake System (Group 4)** is divided into three sections—i.e., **Sec. 4B Air Brakes, Sec. 4C Air Compressor**, and **Sec. 4D Hand Brake. The page number, section number,** and **name of section** appear in the upper left- or right-hand corner of each page.

PAGE AND ILLUSTRATION NUMBERS—The manual pages are numbered consecutively throughout the manual. Illustrations are numbered consecutively **within each manual section.**

INDEXES

SECTION AND PAGE INDEX—The index on Page 8 shows all the sections as they appear in the manual with page number references and coach model application.

ALPHABETICAL INDEX — Pages 9 through 12 alphabetically list subjects with manual page number references.

SECTION CONTENTS—The important subjects included in each section are itemized on the first page of each section. In addition, related sections with page references are also itemized.

SPECIAL TOOLS

Special tools and equipment are mentioned and in many instances illustrated throughout the text. In some instances, such special tools are mentioned by **Vendor's number** in the text or illustrations. These tools are listed at the end of section under the heading **"Special Tools."** This listing includes vendor numbers, and the names and addresses of the vendors from which tool prices availability, etc., may be obtained.

SPECIFICATIONS—Service specifications, fits, and tolerances are listed at the end of each section under the heading **"Specifications."** These specifications include, if necessary, coach model application.

OPERATION—The first section in the book, **Sec. O-Operation,** includes important driving information. Use of controls and other useful information are included.

TROUBLE SHOOTING—The last section in the book, **Sec. 21-Trouble Shooting,** may be used to diagnose some of the common troubles which may be encountered.

SERVICE BULLETINS—Service bulletins are issued supplementing information in each section whenever necessary. The information contained in these bulletins should be noted in the text and the bulletin filed for future reference.

SUGGESTIONS—We are sure that you will find the instructions in this manual a reliable source of **Maintenance and Repair Procedures** on **GMC** Coaches.

Every effort has been made to make the contents of this manual accessible, readable, and accurate. Important construction features and procedures are illustrated and arranged in a practical sequence. Your suggestions for a further improvement of this manual are invited.

WARRANTY

GMC TRUCK & COACH DIVISION–GENERAL MOTORS CORPORATION warrants each new commercial motor vehicle, chassis, or part manufactured by it to be free from defects in material and workmanship under normal use and service, its obligation under this warranty being limited to making good at its factory any part or parts thereof which shall, within ninety (90) days after delivery of such vehicle to the original purchaser or prior to the time when such vehicle has been operated five thousand (5,000) miles, whichever event shall first occur, be returned to it with transportation charges prepaid and which its examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and GMC TRUCK & COACH DIVISION–GENERAL MOTORS CORPORATION neither assumes nor authorizes any other person to assume for it any other liability in connection with the sale of its vehicles.

This warranty shall not apply to any vehicle which shall have been repaired or altered outside of the Manufacturer's factory in any way so as, in the Manufacturer's judgment, to affect its stability, or reliability, nor which has been subject to misuse, negligence or accident, nor to any such vehicle made by GMC TRUCK & COACH DIVISION –GENERAL MOTORS CORPORATION which shall have been operated at a speed exceeding the factory rated speed, or loaded beyond the factory rated load capacity.

GMC TRUCK & COACH DIVISION–GENERAL MOTORS CORPORATION makes no warranty whatever in respect to tires, rims, ignition apparatus, horns or other signaling devices, starting devices, generators, batteries, speedometers or other trade accessories, inasmuch as they are usually warranted separately by their respective manufacturers.

GMC TRUCK & COACH DIVISION
GENERAL MOTORS CORPORATION
PONTIAC, MICHIGAN

GENERAL DATA

The data below includes only general information on models covered by this manual. Specific data and specifications will be found in "Specifications" section of each manual section. For convenience, index of general data items is shown below:

MODEL DATA

PD-3751

Wheel base.....264 in.

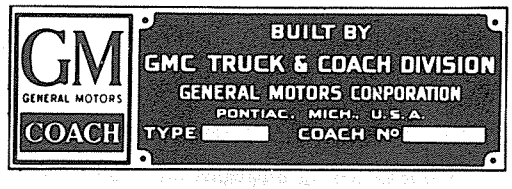
Tire Size.....11:00-19 Single front—Dual rear

Diesel Engine

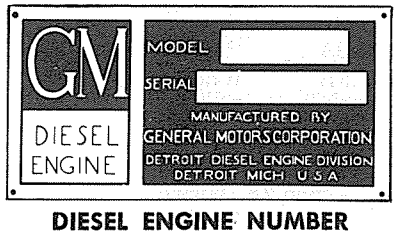
Model 6-71LA35	Governed Engine Speed (no load)
Piston Disp.—Cu. In.....425.31	1st, 2d, or 3d gear—2100 rpm
Bore and Stroke.....4¼ in. x 5 in.	4th gear—1800 rpm
S.A.E. Horsepower.....43.35	Compression Ratio (nominal) 16:1

SERIAL NUMBER LOCATIONS

Delay and confusion can be avoided when correct serial numbers of vehicle are specified on parts orders and correspondence.



CHASSIS NUMBER
PLATE ON INSIDE PANEL
OF ENTRANCE DOOR



DIESEL ENGINE NUMBER
PLATE ON LEFT HAND
SIDE OF ENGINE

TP 3677

Chassis serial number is also stamped on longitudinal underframe rail in tool compartment.

MANUAL GROUP AND SECTION INDEX

The sections in this manual are grouped in sequence as shown in following index.

(1) Section 7A. Wiring and Miscl. Electrical includes wiring diagrams and such electrical equipment that can not be included in other sections. Electrical units applying to various systems are included in respective system sections.

Index

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INDEX

INDEX

O

Operation

Contents of This Section

Related Subjects in Other Sections

Reference should be made to all other sections of this manual for more detailed information on the various major systems of the Coach.

This section includes information and instructions applicable to the operation of the coach from the standpoint of the driver. The information should also serve as an operational guide to the service personnel. In addition to the location and purposes of the controls and instruments, the proper methods of engine, transmission, and brake operation are explained. Use of lights, proper operation of heating and ventilation system, and the access to various units are also itemized. All of the information in this section is of vital importance to the operator, not to teach driver skill but to assist in the efficient operation of the particular GM Coach model covered by this manual.

LOCATION OF CONTROLS

All of the controls, instruments, gauges, and switches which are used by the driver in the operation of the coach are grouped in the driver's compartment as illustrated in figures 1 and 2.

The gauge and switch panels (fig. 2) includes switches, gauges, and signal lights which are used in the control of the engine and lights. The locations and names of these various controls as well as conventional hand and foot levers are clearly shown in the illustrations with their accompanying captions. Uses of the various controls are thoroughly explained in succeeding paragraphs.

In addition to the engine control switches on the instrument panel, sufficient controls are provided in the rear engine compartment to permit operation of engine from that point while accomplishing service on the power plant. The uses of these controls are explained under "Diesel Engine Operation" later in this section.

OTHER OPERATION INFORMATION

These coaches are equipped with Diesel engines. More detailed information regarding operation and maintenance of the Diesel engine will be found in a separate manual (Form No. X-4517).

Sufficient information has been included in this section on special equipment most commonly used. Information may be obtained from the factory on the operation of special equipment which may not be covered in this section.

UNIT ACCESSIBILITY

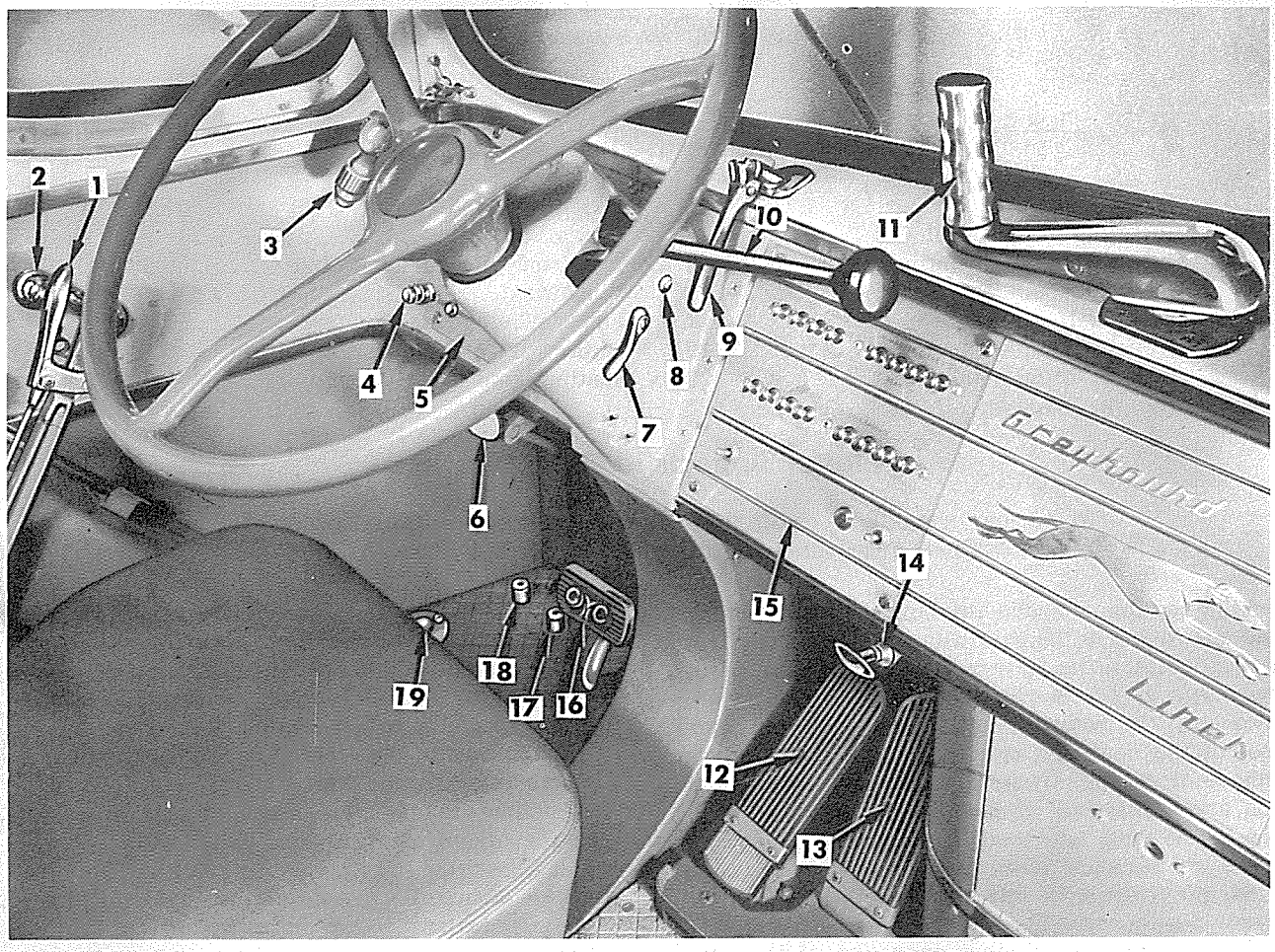
The vehicle is equipped with several doors which must be opened to permit access to various units for service, inspection, adjustment, or repair. Locations of these doors are shown in figure 3. In many instances the driver will have no occasion to utilize some of these access doors; however, the operator should have knowledge of such accessibility for emergency purposes.

INSIDE OF COACH

DESTINATION SIGN

Front destination sign crank is accessible through door above windshields. Door is opened with door lock wrench. Side destination sign crank (when used) is located above rear corner of entrance door.

OPERATION



1 Hand Brake Lever
2 Driver's Side Window Crank
3 Spot Light Handle
4 Windshield Wiper Valve
5 Gauge Panel
6 Driver's Ventilator Control
7 Directional Signal Control Lever
8 Directional Signal Tell-Tale
9 Manual Windshield Wiper Handle
10 Gearshift Lever
11 Door Control Lever
12 Brake Treadle
13 Accelerator Pedal
14 Hand Throttle
15 Switch Panel
16 Clutch Pedal
17 Fog Light Foot Switch
18 Headlight Dimmer Switch
19 Air Horn Foot Valve

TP 3574

Figure 1—Drivers Compartment

FUSE PANELS

Door in dash panel at right of center emblem provides access to fuse panel. Spare fuses are mounted on back of fuse panel door. Main fuse, starter circuit fuse, and engine compartment light fuse are located on control panel at right rear corner of body. Driver's blower switch fuse is located on buzzer panel.

SAFETY EQUIPMENT COMPARTMENT

Safety equipment compartment door, located below fire extinguisher, is opened with door lock wrench. Box on back of compartment door contains flares. Door also provides access to door control linkage.

OUTSIDE OF COACH

SPARE TIRE

Spare tire compartment is located at front of vehicle directly under headlights (fig. 3). Front bumper is mounted on tire compartment door.

OPERATION

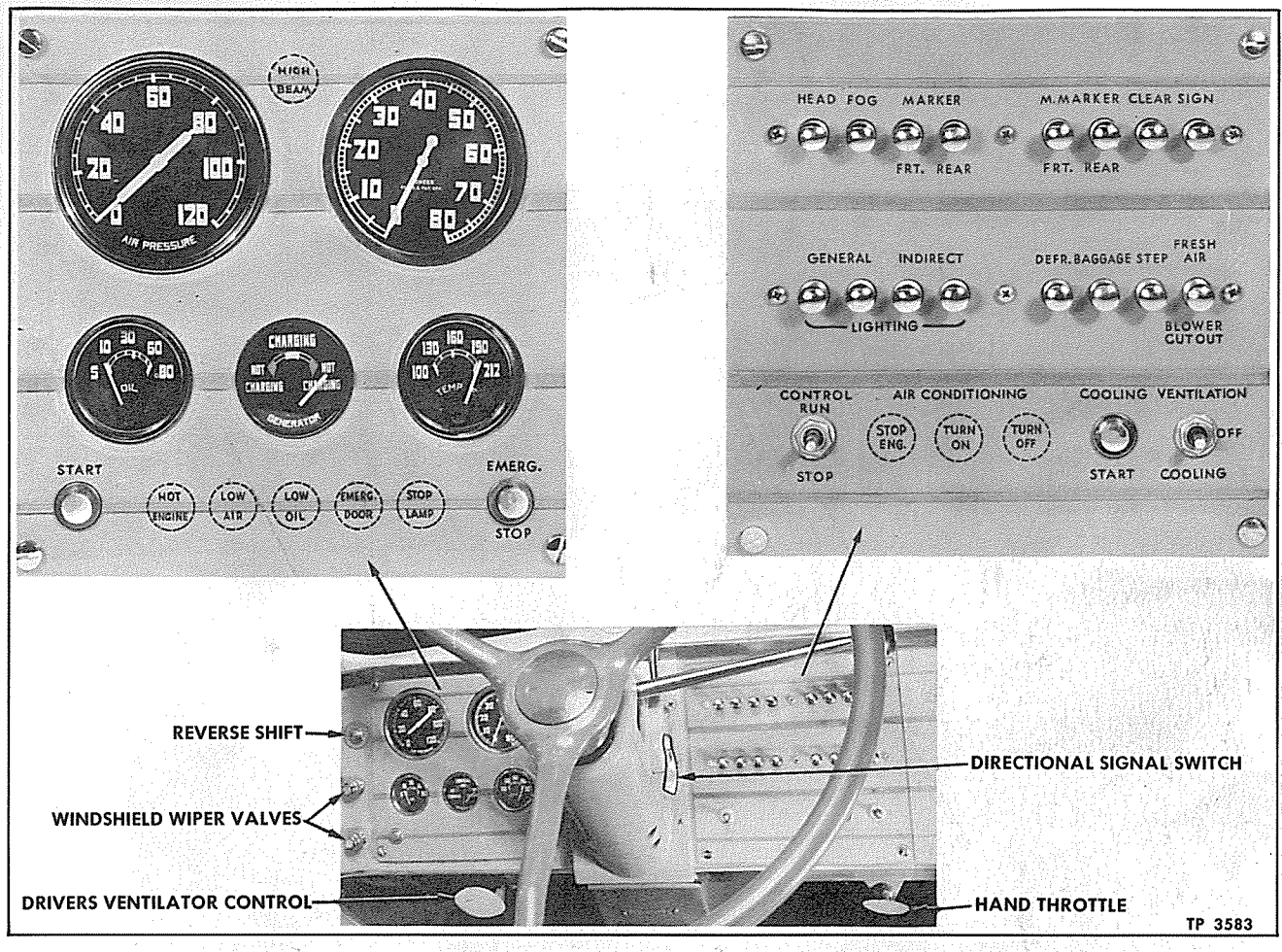


Figure 2—Drivers Gauge and Switch Panels

Sliding access door in bottom of tire compartment provides access to tire valve for gauging or inflating without removing wheel and tire.

TOOL COMPARTMENT

Tool compartment at left front corner of vehicle is accessible through tool compartment door (fig. 3). Door is opened with door lock wrench. This compartment contains jack, jack handle, flare, and miscellaneous tools. This compartment also provides access to air brake pressure test fitting and other air system units, and to lubrication fittings for clutch pedal shaft and steering mechanism.

FUEL AND WATER FILLER NECKS

Diesel fuel tank filler doors are located in right-hand rear side of body, one ahead of and one at rear of right-hand rear wheelhouse (figs. 3 and 4). Doors are opened by inserting finger in hole and pulling outward. Toggle springs hold doors in open or closed position.

Air conditioning engine radiator and fuel tank filler doors are in left-hand front side of body (fig. 3). Doors are opened in same manner as described above.

Diesel engine radiator filler is accessible through left-hand engine compartment door (fig. 3). Door is opened with door lock wrench.

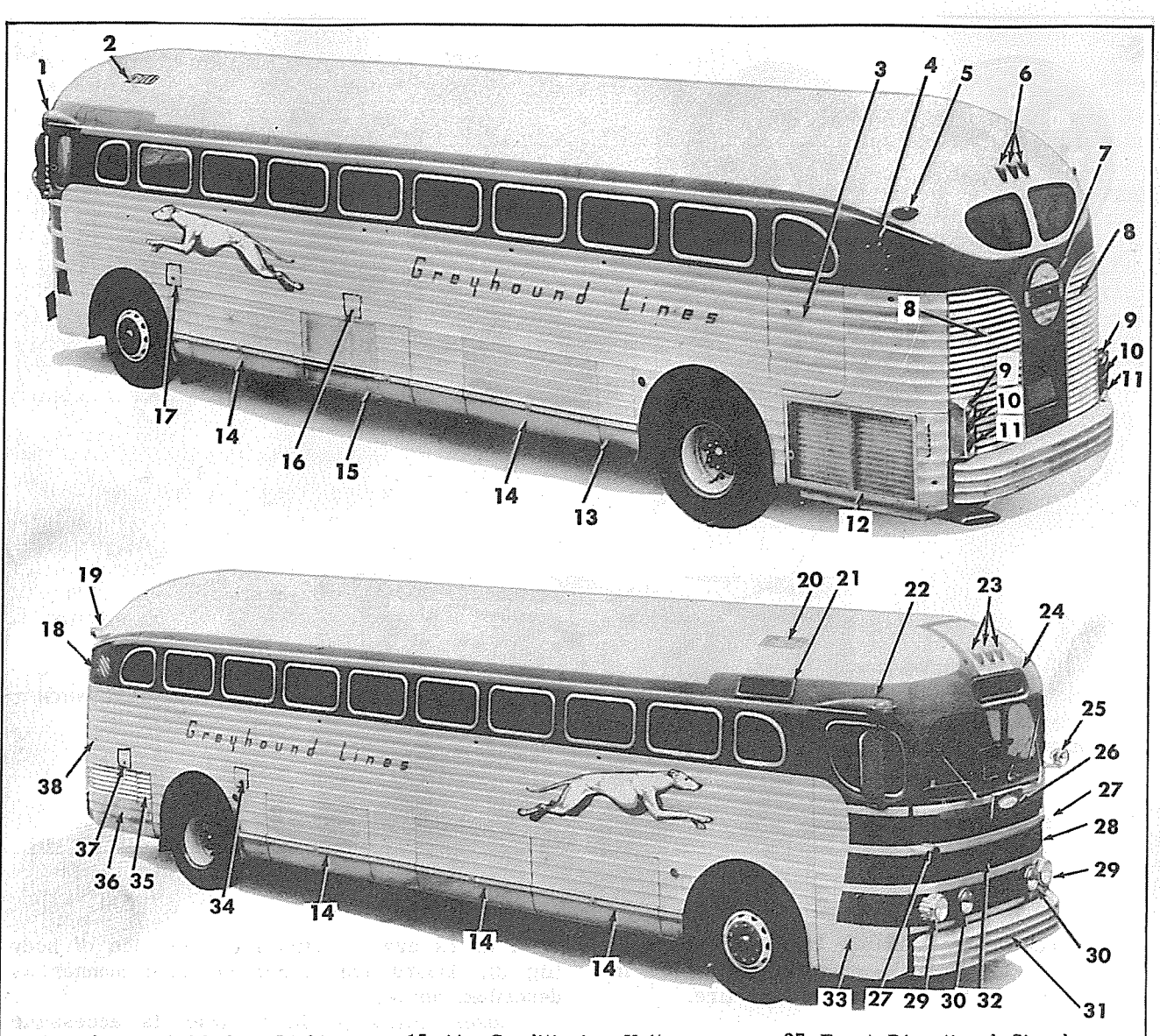
BAGGAGE COMPARTMENT

There are five baggage compartments on vehicles equipped with air conditioning, three on right-hand side of vehicle and two on left-hand side (fig. 3). When air conditioning is not used, air conditioning unit compartment is utilized as a baggage compartment. Baggage compartment doors are opened with door lock wrench. To secure doors in open position, pull chain out of tube and hook into slots in body below windows.

ENGINE COMPARTMENT

Two doors provide access to engine compartment for minor service operations, one at each rear corner of vehicle (fig. 3). Doors are opened with door lock wrench.

OPERATION



1 Left Front Marker Light
2 Fresh Air Intake Grille
3 Emergency Door
4 Engine Air Intake Louvre
5 Left Rear Marker Light
6 Rear Michigan Marker Lights
7 Target Sign
8 Engine Compartment Doors
9 Stop Light
10 Rear Directional Signal Lights
11 Taillights
12 Radiator Shutter Screen
13 Battery Compartment Door
14 Baggage Compartment Doors
15 Air Conditioning Unit Compartment
16 Air Conditioning Engine Radiator Filler Door
17 Air Conditioning Engine Fuel Tank Filler Door
18 Engine Air Intake Louvre
19 Right Rear Marker Light
20 Fresh Air Intake Grille
21 Side Destination Sign (Special Equipment)
22 Right Front Marker Light
23 Front Michigan Marker Lights
24 Front Destingation Sign
25 Spot Light
26 Front Emblem
27 Front Directional Signal Lights
28 Driver's Ventilator
29 Head Lights
30 Fog Lights
31 Front Bumper (Spare Tire Compartment Door)
32 Door Release Button
33 Entrance and Exit Door
34 Frort Fuel Tank Filler Door
35 Fuel Tank Selector Valve Access Door
36 Transmission Inspection Door
37 Rear Fuel Tank Filler Door
38 Rear Engine Control Panel and Regulator Compartment Door

TP 3606

Figure 3—Location of Compartment Doors and Exterior Lights

TRANSMISSION COMPARTMENT

Door on right-hand side at rear corner (fig. 3) provides access to transmission compartment for servicing or inspecting transmission and other units at rear (dirve) end of engine. Door is opened with door lock wrench.

Small door in top forward corner of transmission compartment door (figs. 3 and 4) provides access to fuel tank selector valve without opening transmission compartment door. Small door is opened by inserting fingers between grills and pulling outward at bottom. Spring loaded toggle mechanism holds door in open or closed position.

BATTERY COMPARTMENT

Battery compartment is immediately ahead of left rear wheelhouse (fig. 3). Door is opened with door lock wrench. Safety chain is used to secure door in open position.

ENGINE FUSE AND RELAY PANEL AND REGULATOR COMPARTMENT

Door in right rear corner of body above transmission compartment door (fig. 3) provides access to fuse and relay panel and generator regulator. Generator circuit master fuse and spare fuse is located on this panel. Door is opened with door lock wrench.

FUEL, OIL, AND WATER

FUEL

Fuel tanks are mounted in body underframe, one ahead of and one behind rear axle. Filler necks are accessible through access doors located ahead of and at rear of left rear wheelhouse (fig. 4).

Fuel tank selector valve, accessible through small door in top front corner of transmission compartment door (fig. 4), connects both tanks to the engine fuel lines. Valve may be set to permit fuel to be used from front or rear tank only, or from both tanks.

Reference should be made to Fuel System (Sec. 12A of this manual) for specifications of fuel oil to be used in these coaches. Regular precautions should be taken when filling tanks to prevent static electricity sparks, and to prevent dirt, water, ice, or snow entering tank.

CRANKCASE OIL

Oil reservoir (fig. 4), mounted below radiator surge tank in left-hand side of engine compartment, carries a reserve supply of engine oil for replenishing oil supply in engine crankcase. Engine oil dipstick (fig. 4) is graduated to show level of oil in crankcase. Oil reservoir and dipstick are accessible through left-hand engine compartment door.

After determining quantity of oil required by checking oil level on dipstick, oil is added to engine crankcase by turning valve at top of oil reservoir to the required quantity (fig. 4). Leave valve handle in this position; do not turn handle to "OFF" position except when refilling reservoir. As an example, if two quarts of oil are required in engine crankcase and oil reservoir is full, turn handle to "2" and leave in this position; the nest time two quarts are required in crankcase, turning handle to "4" will permit the required two quarts of oil to drain from reservoir into crankcase. Dipstick on oil reservoir filler cap shows level of oil in reservoir.

When refilling engine crankcase after draining oil, oil is added through oil filler at rear end of engine (fig. 4). Oil filler is accessible through right-hand engine compartment door.

Refer to Lubrication (Sec. 13 of this manual) for engine oil recommendations.

WATER

FILLER CAP

Engine cooling system filler cap in on the surge tank (fig. 4), mounted in upper left-hand corner of engine compartment and accessible through engine compartment left-hand door.

Filler cap has a safety catch which permits the cap to open slightly when filler cap handle is released. If coolant is hot when opening filler cap, stand to one side when releasing handle to prevent being burned by escaping steam. Do not release safety catch until all steam has escaped. After pressure in system has been relieved and steam has stopped escaping, release safety catch and open filler cap. When closing filler cap, make sure safety catch engages edge of cap.

FILLING SYSTEM

To Fill System After Draining

1. Close all drain cocks and install drain plug in radiator outlet connection. Open vent cock at top of thermostat housing. Open radiator filler cap.
2. Fill system to level of filler cap opening.
3. Close vent cock and filler cap.
4. Start engine and run for a few minutes. With engine running, water required to fill heating radiator is drawn from surge tank. The surge tank can then be filled again to level of filler cap opening.

OPERATION

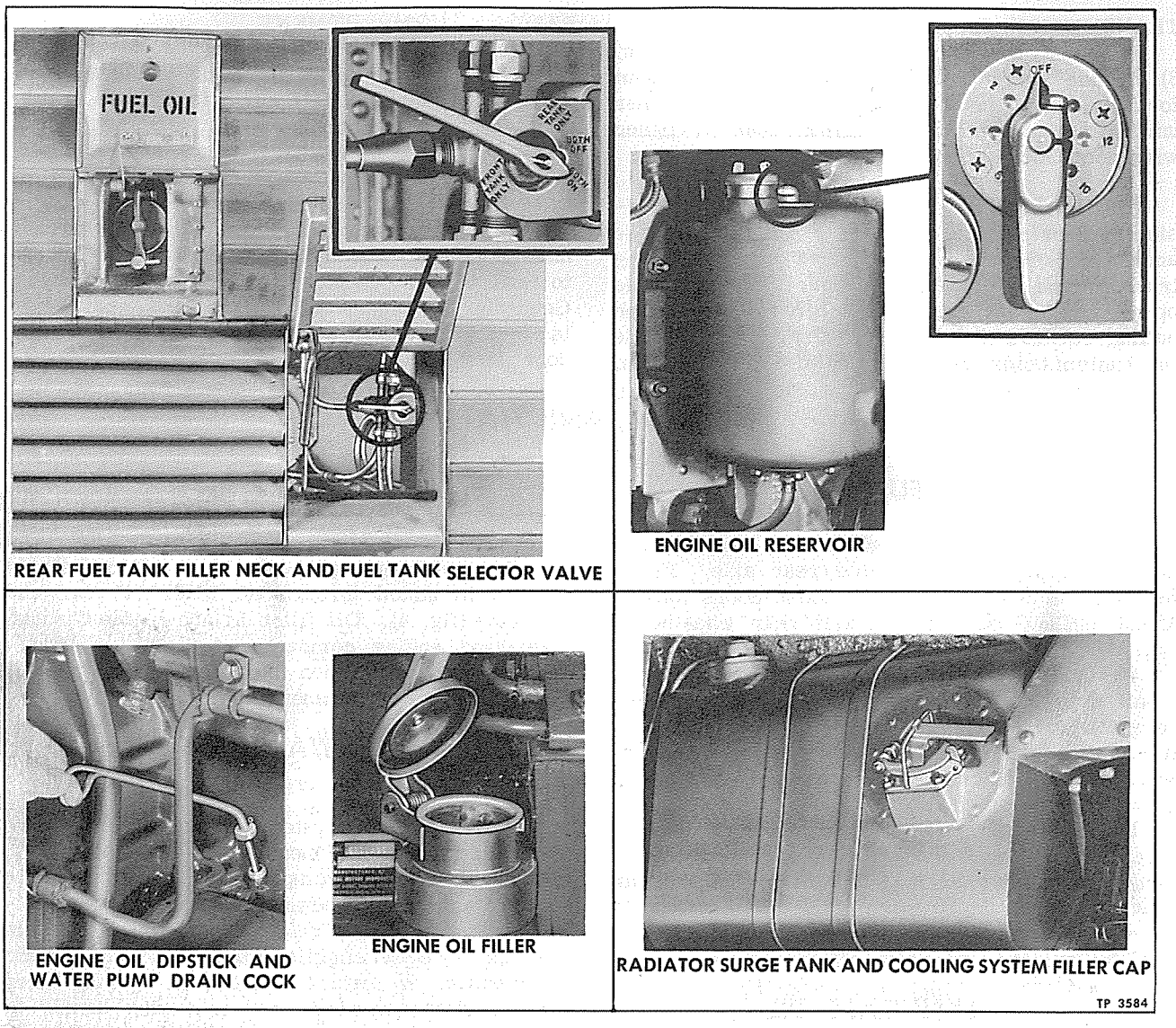


Figure 4—Fuel Oil, Engine Oil, and Water Service Points

To Add Water to System

1. Open radiator filler cap. CAUTION: If coolant is hot, follow instructions previously given under "Filler Cap."

2. With engine running, add water to level of filler cap opening.

3. Should water be lost from cooling system, and engine becomes overheated, do not add cold water immediately - wait until boiling has ceased and engine cooled down. Then, with engine running at idling speed, add water slowly to level of filler cap opening.

CAUTION: Cold water should never be poured into cooling system when engine is hot, as the sudden change in temperature may cause a cracked cylinder head or block.

DRAINING SYSTEM

1. Open filler cap on radiator surge tank, CAUTION: If coolant is hot, follow instructions previously given under "Filler Cap."

2. Open drain cocks and remove drain plug. Drainage points are located as follows: Drain cock at bottom of water pump housing; drain plug in radiator outlet connection at lower rear corner of radiator; drain cock in lower left-hand corner of heating radiator, accessible through left front baggage compartment after removing compartment inner panel.

3. When draining system to prevent freezing, be sure and remove drain plug from air compressor cylinder head.

OPERATION

DIESEL ENGINE OPERATION

DIESEL ENGINE CONTROLS

Controls and gauges for operation of the Diesel engine from the driver's compartment are located in the gauge panel and switch panel (fig. 2). These are: Engine control switch, marked "CONTROL"; engine starter button, marked "START"; emergency stop button, marked "EMERG. STOP"; oil pressure gauge and low oil tell-tale; engine water temperature gauge and hot engine tell-tale; generator charge indicator; hand throttle.

Controls for operating engine from engine compartment at rear of vehicle are accessible through right-hand engine compartment door (fig. 6). These controls are: Engine starter button, marked "START"; engine stop button, marked "ENGINE STOP"; and starter cut-out switch, marked "OPEN WHEN WORKING ON ENGINE." Starter cut-out switch must be in "CLOSED" position when starting engine, either at front or rear.

MOTO-GARD AND TELL-TALE ALARM SYSTEM

Moto-gard and tell-tale alarm system comprises a group of automatic electrical devices which audibly and visually warn the driver that some abnormal condition exists which requires immediate attention. The following four conditions cause the alarm buzzer to sound:

1. Low oil pressure.
2. Overheated engine.
3. Low air pressure.
4. Emergency door open.

Tell-tale lights on drivers gauge panel will indicate which condition is causing the buzzer to sound. In addition to sounding buzzer and lighting tell-tale, the first two of the above conditions will also stop the engine by completing the circuit to the emergency stop solenoid, releasing the air choke valve. Low air pressure or open emergency door only light the tell-tale and sound the buzzer; they do not cause engine to stop. However, vehicle should not be moved when these tell-tales are illuninated.

In the event the moto-gard system stops the engine, it may be necessary to move the vehicle to safety. In case of such an emergency, a drum switch, which is connected to 1st, 2nd, and reverse shift lever at transmission, will break the circuit to the emergency stop solenoid when transmission is in 1st speed. This permits the driver to reset the air choke valve, start engine, and move vehicle to safety with transmission in 1st speed only. To start engine, reset air choke valve, then shift transmission into 1st speed, disengage clutch, and start engine. MOVE VEHICLE ONLY FAR ENOUGH TO REACH SAFETY. Transmission must remain in 1st speed while starting and running engine. Shifting into neutral or any other speed while the faulty condition still exists will immediately close the circuit to the emergency stop solenoid and the air choke valve will again close, stopping engine. Setting of air choke valve is explained below under "Emergency Stop Solenoid."

Note: Action of Moto-gard is not instantaneous. When alarm sounds and low oil or overheat tell-tale illuminates, time lag in action of Moto-gard permits driver to reduce speed and shift into 1st speed, which overrules Moto-gard circuit before the emergency stop solenoid is energized. Thus vehicle may be moved to safety without necessitating resetting the air choke valve. VEHICLE MUST BE STOPPED AS SOON AS POSSIBLE AND CAUSE OF ALARM CORRECTED.

EMERGENCY STOP SOLENOID

Engine emergency stop solenoid (fig. 5) is used as an emergency measure to stop engine in the event the engine fails to stop when "Engine Stop" button is pressed. Emergency stop solenoid is energized by pressing button marked "Emerg. Stop" on drivers gauge panel (fig. 2). Emergency stop solenoid is also energized by low oil pressure switch and by water overheat thermostat as pre-

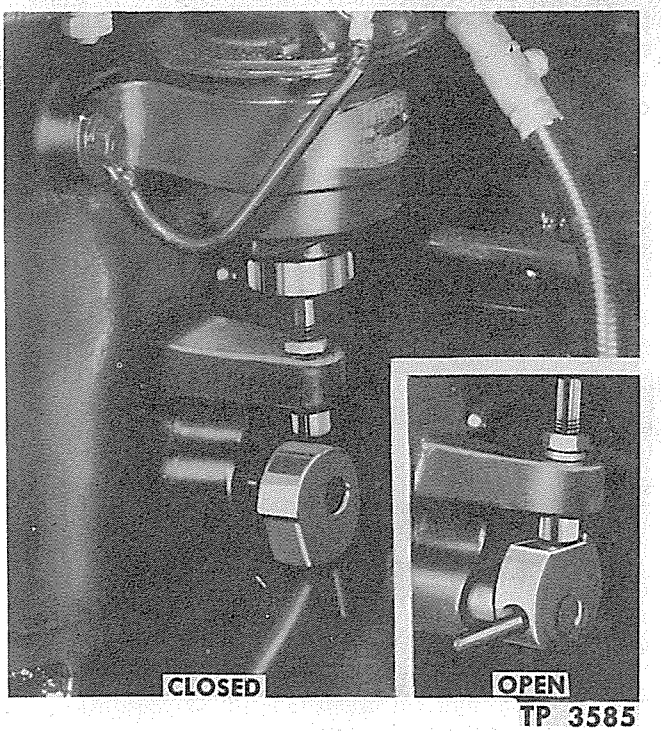


Figure 5—Emergency Stop Solenoid and Air Choke Valve Handle

OPERATION

viously explained under "Moto-Gard and Tell-tale Alarm System." Energizing the emergency stop solenoid pulls solenoid plunger away from release cam on air choke valve shaft, permitting air choke valve to close.

CAUTION: Whenever it has been necessary to press "Emerg. Stop" button to stop engine, do not restart engine until reason for loss of control is determined and corrected.

To reset air choke valve, turn release cam on valve shaft clockwise until shoulder on cam engages emergency stop solenoid plunger (fig. 5).

USE OF HAND THROTTLE

Hand throttle, located under lower right-hand corner of switch panel (fig. 1), is primarily for use in cold climates where low temperatures are prohibitive to stopping engine when vehicle is to remain standing for some length of time. As explained later in this section under "Idling Speed," Diesel engines have a tendency to cool off when running at a slow idle, causing incomplete combustion with its harmful effects on the engine. Also, running engine at idle speed for prolonged periods with lights, heaters, etc., turned on will cause excessive drain on battery. To maintain efficient engine operating temperature, and to maintain sufficient generator output to handle electrical load, set hand throttle to maintain necessary engine speed.

To set hand throttle, depress accelerator pedal to desired position, turn knob clockwise one-quarter turn and pull out just far enough to hold accelerator pedal in position, then turn knob counter-clockwise one-quarter turn. Ratchet mechanism will hold throttle in the desired setting. To release hand throttle, turn knob clockwise one-quarter turn and push in.

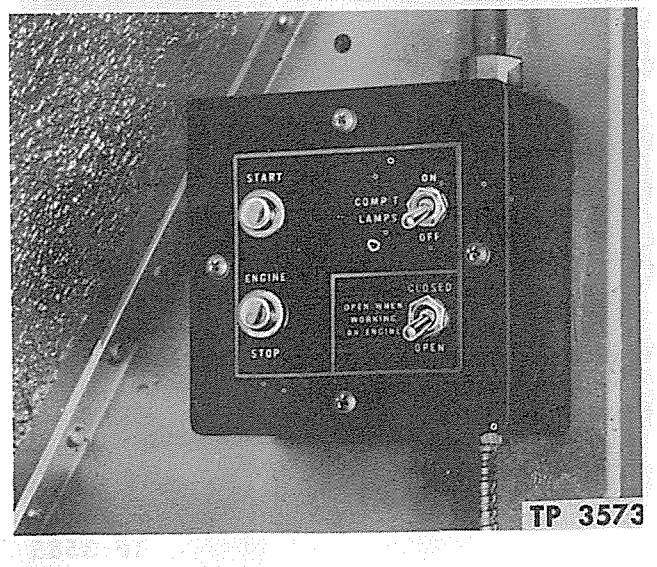


Figure 6—Engine Compartment Control Box

STARTING DIESEL ENGINE AT FRONT

1. With transmission shift lever in neutral position and hand brake lever in fully applied position, press accelerator pedal down as far as possible, then release pedal to move governor control lever from "no-fuel" to idling position.

2. Place engine control switch in "RUN" position to energize starter circuit. NOTE: When control switch is placed in run position, emergency door and low air pressure tell-tale alarm circuits are also energized; if vehicle has been standing for some time and air pressure is low, or of emergency door is open, buzzer will sound and tell-tale will illuminate. If "EMERG. DOOR" tell-tale lights, close emergency door. If "Low Air" tell-tale lights, continue with starting engine, but do not move vehicle until air-pressure has risen sufficiently to shut off tell-tale and buzzer.

3. Disengage clutch, then press "START" button to crank engine. Release button as soon as engine starts. CAUTION: Do not keep starter engaged longer than 10 to 15 seconds at a time. If engine fails to start, release start button and wait 10 to 15 seconds before again engaging starter. Repeat cycle as necessary; however, if engine fails to start in a reasonable length of time, determine and correct cause of failure.

4. Slowly release clutch pedal when engine starts, then observe gauges as explained later under "Diesel Engine Warm-up."

STARTING DIESEL ENGINE AT REAR

1. At front of vehicle, make sure transmission shift lever is in neutral position and that hand brake is fully applied. It is not necessary to place control switch in "Run" position before starting engine at rear.

2. Move governor from "no-fuel" to "idling" position by manually moving control lever (at top of governor) to center position in governor cam.

3. Make sure starter cut-out switch is in "CLOSED" position (fig. 6). Press and hold "START" button to crank engine. Release button as soon as engine starts. Use same precautions regarding use of starter as previously explained under "Starting Engine at Front."

FAILURE TO START

If engine fails to start, reference should be made to the various trouble shooting charts out-

lined in the "Diesel Engine Maintenance Manual," Form X-4517.

COLD WEATHER STARTING

Use of an air heater is recommended when starting of engine becomes a problem at lower atmospheric temperature. Refer to "Cold Weather Starting" in "General Information," Section 17, Diesel Engine Maintenance Manual (Form X-4517).

DIESEL ENGINE WARM-UP

It is recommended that the Diesel engine be permitted to go through a short warm-up period to permit driver to observe gauges and operation before engine is placed under load. During this warm-up period the following precautions and observations should be made.

IDLING SPEED

When starting a cold engine, increase engine speed to a fast idle (1/3 throttle - approximately 600 rpm) as soon as engine starts. Unlike conventional gasoline engines, Diesel engines have a tendency to get cold when running at a slow idle. Incomplete combustion in a cold, slow-idling Diesel engine causes formation of harmful deposits on engine parts, with possibly more serious damage resulting.

OIL PRESSURE

When the engine is first started, consistency of the oil may cause a slight rise in the pressure reading on the oil gauge. After engine warms up, the pressure should recede slowly to normal. Normal readings are: Idling - 4 pounds minimum; governed speed - 25 pounds minimum.

Oil pressure gauges, one in gauge panel and one on engine, do not indicate the quantity of oil in the crankcase. This may be determined only by a visual check of the crankcase dipstick as previously explained in this section under "Fuel, Oil, and Water."

Low oil pressure switch, mounted on left front side of engine, is electrically connected into the Moto-gard and tell-tale alarm system. Operation of this system is explained elsewhere in this section under "Moto-gard and Tell-tale Alarm System."

OPERATING TEMPERATURE

Efficient operating temperature of the GM Series 71 Diesel Engine is 160°F. to 185°F., (180°F. preferable). Maintain this temperature under all operating conditions. If conditions permit, avoid moving vehicle until thermo gauge indicates a coolant temperature of at least 140°F. However, idling for reasonable maneuvering, loading, or unloading is permissible. AVOID ALL UNNECESSARY IDLING. Stop engine when vehicle is to remain standing for any length of time. NOTE: When operating vehicle in cold climate, it may be undesirable to stop engine when vehicle is to remain standing. In this case, engine should be run at a fast idle as explained previously in this section under "Use of Hand Throttle."

GENERATOR CHARGING

Generator charge indicator on gauge panel (fig. 2) indicates three conditions.

1. With pointer in red segment on left-hand side, generating circuit is complete but generator is not supplying sufficient current to handle the electrical load and the battery is being discharged.
2. With pointer in red segment on right-hand side, generating circuit is open. This may be caused by a blown main fuse, engine control switch off, defective voltage regulator, or broken or defective wiring.
3. With pointer in cream (center) segment, generator is charging properly.

AIR PRESSURE

During the warm-up period, the air pressure should continue to build up to the compressor cut-out pressure (100-105 lbs.). Do not race a Diesel engine to pump up air pressure. Do not use over 1/3 throttle. No attempt should be made to move the vehicle until pressure is at least 70-75 lbs. These vehicles are equipped with a low air pressure alarm system. The buzzer will sound and tell-tale on gauge panel will illuminate when the air pressure drops between 54-66 lbs., and tell-tale will remain illuminated until pressure reaches this minimum.

DURING DIESEL ENGINE OPERATION

During operation of Diesel engine, the driver should observe the readings of the gauges. By these readings the driver can determine, in many instances, any abnormal symptoms which may affect the operation of the engine. In addition to observations of gauges and signals, there are some practices peculiar to Diesel engine which must be followed.

Most efficient and economical operation of engine will be obtained by maintaining engine speed of 1500 to 2000 rpm when operating vehicle under full load. Maintain engine speed by careful selection of transmission gears.

Lugging, that is, operating engine below 1500 rpm with throttle fully opened, or under any condition where black smoke can be noticed from exhaust, should be avoided.

OPERATION

USING DIESEL ENGINE AS A BRAKE

When descending grades, engine may be used as a brake in checking vehicle speed. Braking effect of engine increases with its speed. The maximum speed, however, must not exceed 2000 rpm. Engine running at governed speed will safely hold vehicle descending a grade in the same gear as is required to climb the same grade. There is no need to use the stop switch since the governor will automatically cut off the fuel supply whenever the accelerator is released to idling position and the engine speed is above 400 rpm.

OBSERVATION OF GAUGES AND SIGNALS

Operating Temperature. As previously stated under "Engine Warm-up," efficient engine operating temperature is 160°F. - 185°F. (preferably 180°F). If temperature suddenly approaches 212°F., stop vehicle and determine cause of high temperature and make necessary corrections. When temperature reaches 212°F., engine overheat thermostat closes circuit which actuates Moto-gard and tell-tale alarm system and engine will automatically stop. Operation of this system is explained elsewhere in this section under "Moto-gard and Tell-tale Alarm System." By stopping vehicle and correcting cause of high temperature before the temperature reaches 212°F., the inconvenience occasioned by the emergency stop is eleminated.

Oil Pressure. Immediately stop engine if oil pressure gauge shows an abnormally low reading. Determine cause of low oil pressure and make necessary correction. If oil pressure drops below 3 pounds, low oil pressure switch contacts close, actuating Moto-gard and tell-tale alarm system, automatically stopping engine. Operation of this system is explained elsewhere in this section under "Moto-gard and Tell-tale Alarm System."

Air Pressure. Immediately stop vehicle and determine cause of consistently low air pressure, or if buzzer sounds and low air pressure tell-tale illuminates.

Generator Charging. Generator charge indicator points should remain in cream (center) segment during normal operation. Pointer in red segment at left indicates that battery is being discharged. Pointer in red segment at right indicates open generating circuit. This may be caused by blown main fuse, engine control in off position, defective voltage regulator, or defective wiring. Stop vehicle, and locate and correct cause of open circuit.

STOPPING ENGINE

AT FRONT

Set hand brake lever in fully applied position. Shift transmission into neutral or keep clutch disengaged until engine stops. It is a good practice to permit engine to idle for approximately 30 seconds before stopping. Place control switch on switch panel (fig. 2) in "STOP" position. It is not necessary to hold switch in "STOP" position until engine stops.

If engine fails to stop, press "EMERG. STOP" button on gauge panel (fig. 2). Whenever "EMERG. STOP" button is used to stop engine, air choke valve in blower air intake must be re-set manually before engine can be started (fig. 5). CAUTION: Do not re-start engine until reason for loss of control is determined and corrected. To re-set choke valve, swing handle up to horizontal (open) position (fig. 5).

AT REAR

Press "ENGINE STOP" button on control box in engine compartment (fig. 6). In the event engine fails to stop, raise emergency stop solenoid plunger (fig. 5) manually to release air choke valve. Whenever emergency stop has been used, air choke valve must be re-set as described in preceding paragraph.

USE OF TRANSMISSIONS

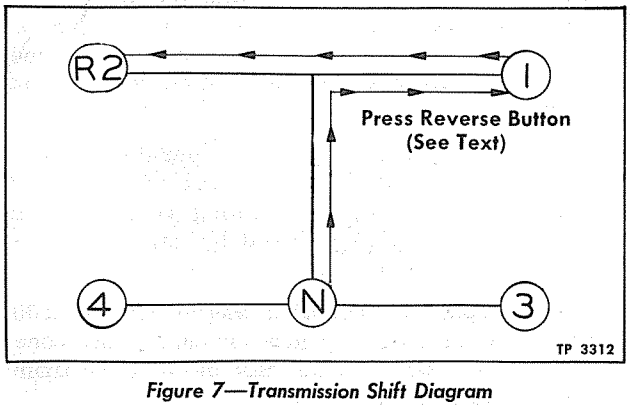


Figure 7—Transmission Shift Diagram

Transmission has four forward speeds and one reverse. Shift lever positions are illustrated in figure 7. Reverse shift pattern is indicated by arrows in figure 7.

GENERAL CAUTIONS

Avoid Clashing Gears - serious damage can result.

Do not Shift Into Reverse when vehicle is moving forward.

Do not Shift Into Any Forward Speed when vehicle is moving backward.

Shift Into Next Lower Gear BEFORE engine begins to labor, when ascending grades, or in snow, etc.

OPERATION

LOW TO HIGH SHIFTING

Double-clutching method is recommended when shifting from 1st to higher gears. Progressively shift from 1st to 4th - do not skip speeds. Do not attempt to shift into next higher speed until sufficient road speed has been attained.

HIGH TO LOW SHIFTING

Always shift into the next lower gear before engine begins to labor. Make use of the lower gears when ascending or descending a grade, in snow, mud, or off-the-road service. Always progressively shift into lower gears. Do not skip speeds. Always use double-clutching method when shifting from high to low speeds.

REVERSING

The engine control switch must be in "RUN" position to energize the reverse shift solenoid circuit before the transmission can be shifted into reverse position. Shift into reverse is made as follows:

1. With vehicle at a complete stop and clutch pedal depressed, move shift lever from neutral (N) to 1st (fig. 7).
2. Press "REVERSE SHIFT" button at left of gauge panel (fig. 2). While holding button in, shift lever into "R2" position (fig. 7).
3. Transmission is now in reverse gear, and vehicle can be backed by releasing clutch pedal slowly and simultaneously depressing accelerator pedal.

To shift from reverse to neutral, the following procedure must be used:

1. With vehicle at a complete stop, depress clutch pedal.
2. Move shift lever from reverse to 1st speed position, then into neutral. It is not necessary to push "REVERSE SHIFT" button when shifting out of reverse.

NOTE: After moving shift lever from reverse position, lever must always be moved to 1st speed position before shifting to other forward speeds.

USE OF BRAKES

Brakes are applied by depressing the brake treadle, located on toeboard to the left of the accelerator pedal (fig. 1). Varying degrees of brake application are obtained by varying the distance the treadle is depressed. From a driver's viewpoint, operation of brakes on an air brake equipped vehicle is only slightly different than on a vehicle equipped with conventional hydraulic or mechanical brakes. The following brief operating instructions should familiarize the driver with operation of air brakes.

AIR PRESSURE

Before moving the vehicle, observe air pressure registered on air pressure gauge. Reservoir pressure must be at least 70 to 75 pounds before air brakes can develop their full effectiveness. Observe this pressure frequently while vehicle is in motion. If at any time the air pressure drops below 75 pounds, stop the vehicle immediately. These vehicles are equipped with a low air pressure alarm system. When air pressure drops below 66-54 lbs., buzzer will sound and "LOW AIR" tell-tale on gauge panel (fig. 2) will illuminate. Stop vehicle immediately when alarm sounds, and locate and correct cause of pressure loss before moving vehicle.

APPLYING BRAKES

Best braking effect will be obtained by making original brake application as hard as speed and road conditions permit, then reducing application pressure gradually as speed is reduced so that at end of stop only a slight pressure remains in brake chambers. Do not first apply brakes lightly, then increase application pressure as speed decreases. This not only requires more time for a stop, but the final high pressure will produce a severe final stop.

Do not "fan" the brake treadle. This causes poor brake performance, wastes air pressure, and causes excessive wear on brake operating units and brake lining. "Fanning" does not increase brake line pressure, but decreases both reservoir and line pressure.

When brake pedal is depressed, stop light switch functions to light stop lights. Tell-tale marked "STOP LAMP" on gauge panel (fig. 2) will illuminate when stop lights are on. Failure of tell-tale to illuminate when brakes are applied indicates burned out stop light bulbs or a blown stop light circuit fuse.

USE OF HAND BRAKE

Hand brake is applied by hand brake lever at left of driver. As a safety measure, always apply hand brake whenever vehicle is parked, and whenever driver leaves vehicle.

Hand brake can be used to stop vehicle in the event of failure of service brakes. However, relatively small area of braking surface will require a much longer distance to stop vehicle than that required when using service brakes. Hand brake should never be used to stop vehicle except in case of emergency.

OPERATION

USE OF LIGHTS

All internal and external lights, with the exception of engine compartment lights and stop light, are controlled by switches in the driver's compartment. The engine compartment lights are controlled by a switch mounted in engine compartment control panel. Stop light is controlled by an air operated switch connected into brake system. In some instances, light switches on switch panel (fig. 2) control several lights in addition to the lights indicated on switch panel. Each switch and the lights which it controls is listed below under "Light Switches."

LIGHT SWITCHES

HEAD

Switch controls circuit to headlights, dimmer switch, and high beam tell-tale.

FOG

Switch controls circuit to fog lights. Lights are turned on and off by foot switch (fig. 1).

MARKER - FRONT

Switch controls circuit to front marker lights.

MARKER - REAR

In addition to controlling rear marker lights, this switch controls circuit to panel lights, taillights, target sign lights, and reading lights. Reading lights are turned on and off by individual switches. The first four of these light circuits are protected by the same fuse; reading lights are divided into two circuits, each circuit being protected by a separate fuse.

M. MARKER - FRONT AND REAR

Two switch controls circuit to front and rear Michigan marker lights.

CLEAR

Switch controls circuit to side clearance lights (when used). Switch is ineffective on vehicles not equipped with side clearance lights.

SIGN

In addition to controlling circuit to front destination sign lights (and side destination, when used), this switch controls circuit to front emblem light and night lights. All of these circuits are protected by a single fuse.

GENERAL LIGHTING

Two switches control circuits to dome lights above passenger seats. These lights permit driver to light up interior of coach when all reading lights are turned off by individual switches.

INDIRECT LIGHTING

Two switches control circuits to indirect lights in upper edge of package rack rails.

BAGGAGE

Switch controls circuit to all baggage compartment lights. Light in each compartment is turned on and off by individual switches.

STEP

Switch controls circuit to step lights. Lights are automatically turned on and off by a switch operated by door control linkage.

DRIVER'S LIGHT SWITCH

Driver's light switch is located at driver's light on trim panel above driver's window.

SPOT LIGHT SWITCH

Spot light switch is located on spot light control handle.

EXTERIOR LIGHTS

HEADLIGHTS

Headlights are controlled by a push-pull type switch on switch panel, marked "HEAD" (fig. 2). After switch is pulled out, high and low beams are selected by use of dimmer switch on floor (fig. 1). High beam is generally used for highway operation. Low beam is used when approaching another vehicle or for city driving. Tell-tale at top of gauge panel marked "HIGH BEAM" (fig. 2) illuminates when high beam is selected.

FOG LIGHTS

Fog light circuit is energized when switch marked "FOG" (fig. 2) is pulled out. Fog lights can then be turned on or off by fog light foot switch on floor (fig. 1).

DIRECTIONAL SIGNAL LIGHTS

Directional signal lights are controlled by lever type switch on side of gearshift and steering gear housing (fig. 1). Pulling lever up turns on left-hand front and rear signal lights; pressing lever down turns on right-hand front and rear signal lights. Tell-tale on switch housing flashes on and off when either right or left-hand signal lights are illuminated.

DESTINATION SIGN LIGHTS

Front destination sign lights (and side destination sign when used) are turned on when switch marked "SIGN" (fig. 2) is pulled out. This switch also turns on front emblem light and interior night lights.

MICHIGAN MARKER LIGHTS

Front and rear Michigan marker lights are turned on when two switches marked "M. MARKER" (fig. 2) are pulled out. Michigan marker lights are the three lights at top center of vehicle, front and rear.

MARKER LIGHTS

Marker lights at each top corner of vehicle are controlled by two switches marked "MARKER" (fig. 2). Rear marker light switch also turns on panel lights, taillights, target sign lights, and energizes circuit to passenger reading lights. Reading lights are turned on and off by individual switches at the lights.

TAILLIGHTS

Taillights are illuminated when switch marked "MARKER-REAR" (fig. 2) is pulled out.

SPOT LIGHT

Spot light is turned on and off by switch on spot light control handle (fig. 1).

FRONT EMBLEM LIGHT

Front emblem light is turned on when switch marked "SIGN" (fig. 2) is pulled out.

CLEARANCE LIGHTS

Side clearance lights, when used, are turned on when switch marked "CLEAR" (fig. 2) is pulled out. This switch is ineffective when vehicle is not equipped with side clearance lights.

STOP LIGHTS

Stop lights at each rear corner and in target sign are illuminated by action of air operated switch when brakes are applied. Tell-tale on gauge panel marked "STOP LAMP" (fig. 2) illuminates when stop lights are on. Failure of tell-tale to illuminate when brakes are applied indicates burned out stop light bulb or fuse, or other trouble in the stop light circuit.

INTERIOR LIGHTS

DRIVER'S LIGHT

Driver's light, on trim panel above driver's window, is turned on and off by a switch at the light.

NIGHT LIGHTS

Blue night lights, near rear of vehicle, are illuminated when switch marked "SIGN" (fig. 2) is pulled out.

INDIRECT LIGHTS

Indirect lights, in top edge of package rack rails, are turned on and off by two switches marked "INDIRECT" (fig. 2).

READING LIGHTS

Reading light circuit is energized when switch marked "MARKER-REAR" (fig. 2) is pulled out. Each light is turned on and off by individual switches at lights.

GENERAL LIGHTS

General lights, one above each pair of seats, are turned on and off by switches marked "GENERAL" (fig. 2). These lights permit driver to light up interior of coach when all reading lights are turned off by individual switches.

PANEL LIGHTS

Panel lights illuminate driver's gauge panel when switch marked "MARKER-REAR" (fig. 2) is pulled out.

STEP LIGHTS

Step light circuit is energized when switch marked "STEP" (fig. 2) is pulled out. Lights are automatically turned on and off when door is opened and closed.

COMPARTMENT LIGHTS

BAGGAGE COMPARTMENT LIGHTS

Baggage compartment lights are turned on and off by individual switches in the compartments after switch marked "BAGGAGE" (fig. 2) is pulled out. Switches in compartments are automatically turned on and off by opening and closing of baggage compartment doors.

ENGINE COMPARTMENT LIGHTS

Engine compartment lights are turned on and off by switch marked "COMP'T LAMPS" on engine compartment control box (fig. 6).

TELL-TALE LIGHTS

Tell-tale lights located in driver's gauge panel (fig. 2) are barely visible except when light is illuminated. Purpose of each tell-tale is explained below.

HOT ENGINE, LOW OIL, LOW AIR, AND EMERGENCY DOOR TELL-TALE LIGHTS

These tell-tales, located at bottom of driver's gauge panel (fig. 2) operate in conjunction with Moto-gard and tell-tale alarm system. Operation of this system is explained elsewhere in this section under "Moto-gard and Tell-tale Alarm System."

STOP LAMP TELL-TALE LIGHT

Stop lamp tell-tale light illuminates when brakes are applied to assure driver that stop lights are illuminated. Failure of tell-tale to illuminate when

OPERATION

brakes are applied serves to warn driver that stop lights are not illuminated.

HIGH BEAM TELL-TALE LIGHT

High beam tell-tale serves to aid driver in selecting headlight high and low beams with foot dimmer switch. Tell-tale is illuminated when headlight high beam is selected.

DIRECTIONAL SIGNAL TELL-TALE LIGHT

Directional signal tell-tale light on right-hand side of steering gear and gearshift housing flashes on and off when either right or left directional signals are on. This assures driver that directional signals are working properly, and also serves to remind driver to turn signals off when turn is completed.

DOOR AND RETRACTABLE STEP

Passenger entrance and exit door is manually operated by the door control lever, located on windshield ledge (fig. 1). Door can be opened independently or in conjunction with retractable step.

To open door without lowering step, lift up on door control handle, then swing handle in a counterclockwise direction. Push handle around as far as possible to lock door in open position.

To lower retractable step simultaneously with opening of door, press down on door control handle before opening door.

Door can be opened from outside vehicle by pressing release button extending through front body panel above front license compartment (fig. 3). Pressing release button unlocks door mechanism, permitting door to be pulled open.

In the event damage to step prevents closing door, step can be easily removed as directed in Body (Sec. 3B of this manual).

WINDOWS

SIDE WINDOWS

Emergency Escape

Side window sash are hinged at bottom to provide passenger escape under emergency conditions. Sash is held in closed position by spring-loaded latches at top. A strong push against top of window overcomes latch springs and causes window to swing outward and downward against body side. CAUTION: Windows should be opened in this manner only in case of emergency, since damage to body, sash frame, or glass usually results.

Ventilation

Side windows can be opened for ventilation in event of failure of air-conditioning unit. Each window regulator must be individually unlocked with driver's key. Rear of window can then be opened outward approximately 1-1/2 inches.

ENTRANCE DOOR AND DRIVER'S WINDOWS

Entrance door and driver's windows can be lowered and raised by conventional crank-type window regulators.

SPARE WHEEL AND TIRE

REMOVAL

1. Remove cap nuts from two tire compartment door studs (fig. 8). Swing bumper and tire compartment door downward.

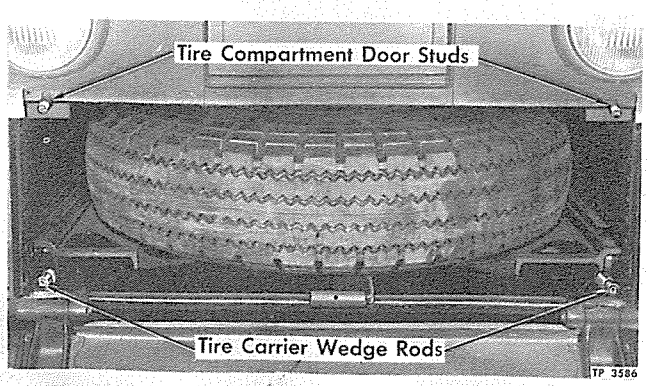


Figure 8—Spare Tire Compartment

2. Turn tire carrier lock bar one-quarter turn and pull bar out from between tire carrier and bottom of compartment.

3. Using door lock wrench, turn tire carrier wedge rods counterclockwise to lower carrier onto rollers. Grasp carrier at each side and pull out.

4. Remove spare tire hold-down nut and bar. Remove wheel and tire from carrier.

INSTALLATION

1. Place wheel and tire on carrier with valve stem pointing downward. Valve stem should be toward front of vehicle to permit gauging or inflation through access door in bottom of compartment.

2. Attach wheel and tire to carrier with hold-down bar and nut.

3. Lift carrier and push into compartment. Using door lock wrench, turn tire carrier wedge rods clockwise to lift carrier up off rollers.

4. Push tire carrier lock bar in between carrier and bottom of compartment, then turn bar on edge as shown in figure 8.

5. Swing door and bumper up, install cap nuts on studs, and tighten securely.

BATTERY CABLE CONNECTOR BLOCK

Battery cable connector block (fig. 9) is accessible through door immediately ahead of left rear wheel. Connector block is so designed that battery cables may be quickly disconnected in the event a short in the electrical system necessitates such action. To disconnect cables, press retainer bar latch to left; spring loaded retainer bar will fly open and cables can be pulled out of notches in block.

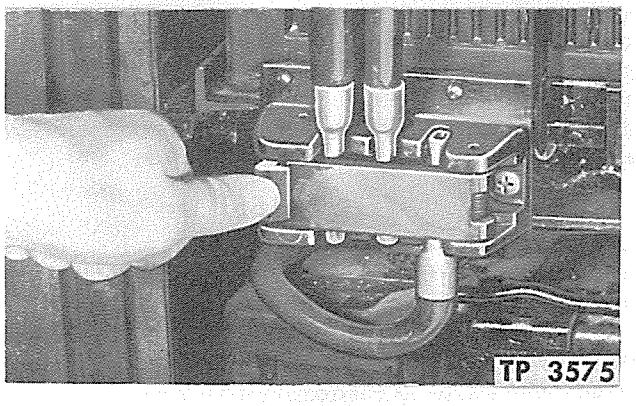


Figure 9—Battery Cable Connector Block

HEATING AND VENTILATION

The heating and ventilation operating instructions shown in succeeding paragraphs describe only the standard heating and ventilating systems. These instructions do not include any operation of Air Conditioning Units. Instructions on Air Conditioning may be obtained from the manufacturer of that equipment.

VENTILATION

Coach is ventilated by motor driven blowers, which operate efficiently only with all windows closed. In event of failure of ventilating system, windows can be opened as described earlier in this section.

MAIN BLOWER CONTROL

Main ventilator blowers are controlled by "Ventilation" switch at lower right corner of driver's switch panel (fig. 2). Under normal operating conditions (except when cooling is desired) switch lever should be moved up to "Ventilation" position while coach is in operation. Main blower also operates with switch in "Cooling" position.

FRESH AIR BLOWER CONTROL

Fresh air intake blowers are also controlled by "Ventilation" switch on standard system. Intake blowers operate with switch in either "Ventilation" or "Cooling" positions. Intake blowers may be turned off, with switch in "Ventilation" position, by pulling "Fresh Air Blower Cutout" switch (fig. 2). This is a momentary switch and returns to off position when released. However, momentary closing of switch prevents operation of intake blowers until position of "Ventilation" switch is changed. With "Ventilation" switch in "Cooling" position, "Fresh Air Blower Cutout" switch is ineffective.

On Special (N.Y.) system, fresh air intake blowers are connected to coach engine generator circuit, and operate whenever generator is charging regardless of "Ventilation" switch position. "Fresh Air Blower Cutout" switch is not connected, and consequently is inoperative in this system.

HEATING

Vehicle is warmed by a single heating radiator in air duct in front baggage compartment. Heating radiator is supplied with hot water from vehicle engine.

Heating is entirely automatic, the driver having no direct control of this function. In the event coach becomes excessively warm due to failure of heating radiator thermostat, heat can be shut off by closing valve in heater supply line in engine compartment.

OPERATION

DEFROSTING

Deflectors at top of each windshield section are connected to vehicle air ducts and convey conditioned air to windshield for normal defrosting. Additional defrosting is provided by a fan mounted in each vertical duct at rear of entrance door and driver's window. Fans, mounted behind adjustable grilles in front of vertical ducts, are controlled by "Defr." swtich in switch panel (fig. 2). Grille shutters may be opened or closed, as desired, by knob at side of grille.

TELL-TALES

Three "Air Conditioning" tell-tale lights are mounted on driver's switch panel between "Control" switch and "Cooling Start" button (fig. 2). Wording is visible only when tell-tales are illuminated.

Tell-tales are used in connection with air cooling unit, and instructions may be obtained from manufacturer of the cooling equipment.

Since two of the tell-tales may be lighted even when air conditioning unit is omitted, following is a brief description of their operation:

1. "Stop Eng." tell-tale is operative only with air conditioning unit installed.
2. "Turn On" tell-tale circuit is energized in "Run" position of "Control" switch. Thermostat, on left-hand vertical air duct, lights tell-tale when coach interior temperature rises to (exceeds) 76°F.
3. "Turn Off" tell-tale circuit is energized in "Cooling" position of "Ventilation" switch. Thermostat, is left-hand fresh air duct, light tell-tale when temperature of incoming fresh air falls to 55°F.

Front End Alignment

Contents of This Section

Related Subjects in Other Sections

Front end alignment chart, shown in figure 1, illustrates the various points from which front end alignment dimensions are taken.

Reference should be made to "Wheel Alignment Dimensions," at end of this section, for correct alignment data pertaining to particular model being checked. Refer to Trouble Shooting (Sec. 21 of this manual) for alignment trouble symptoms causes, and probable remedies.

Proper alignment of front wheels must be maintained in order to insure ease of steering and satisfactory tire life. The most important factors of front wheel alignment are: wheel camber, axle caster and wheel toe-in, which are described briefly in succeeding paragraphs.

These points should be checked at regular intervals, particularly where front axle has been subjected to heavy impacts due to collision or hard curb bumps

When checking wheel alignment, it is important that wheel bearings and steering knuckle bearings be in proper adjustment. Loose bearings will affect reading of instruments when checking camber, king pin inclination, and wheel toe-in.

When performing front end alignment check, instructions relating to front end alignment, outlined in this section, should be carefully followed as well as instructions covering other related units such as steering gear, brakes, springs, hubs and bearings, wheels, and tire inflation. These related instructions can be found in their respective sections. Refer to index above.

Adherence to alignment data, listed in "Wheel Alignment Dimensions" at end of this section, is strongly recommended. Precision equipment and instruments should be made available for accurate check-up and corrective work. Refer to figure 1 frequently when checking front end alignment.

FRONT END ALIGNMENT FACTORS

Front end alignment factors discussed in this group include: FRONT WHEEL TOE-IN, FRONT WHEEL CAMBER, AXLE CASTER, KING PIN INCLINATION, AND STEERING GEOMETRY. These terms may be defined, briefly, as follows:

Wheel Toe-in - Distance front wheels are closer together at front than at rear of axle (See "J" and "H" on chart).

Wheel Camber - or Pitch - The amount of wheel inclination from a vertical position.

Positive Camber - Outward inclination of wheels at top (See "C" on Chart).

Zero Camber - No inclination - wheels are held in vertical plane.

Negative or Reverse Camber - Inward inclination of wheels at top.

Front Axle Caster - Inclination of king pin from the vertical in the fore and aft direction of the vehicle.

Positive Caster - Inclination of king pins toward rear of vehicle (See "N" on Chart).

Zero Caster - King pins are held in a vertical position.

Negative or Reverse Caster - Inclination of king pins toward front of vehicle.

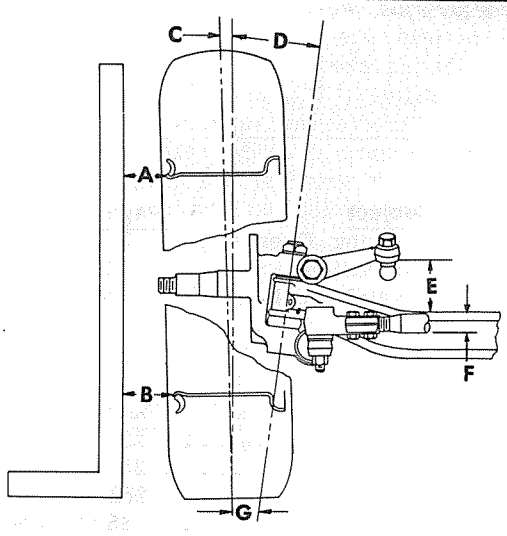
King Pin Inclination - The slant of the king pin toward the center of the vehicle at the top, and outward at the bottom. (See "D" on Chart).

Steering Geometry - The mechanics of keeping front wheels in proper relative alignment as wheels are turned to extreme right or left.

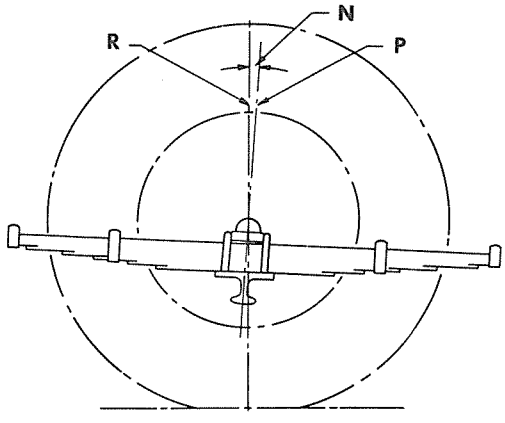
FRONT WHEEL TOE-IN

The purpose of toe-in is to offset the effect of camber, thus preventing side slipage and cross wear of tires. Since camber and toe-in bear a definite relation to each other, both should be

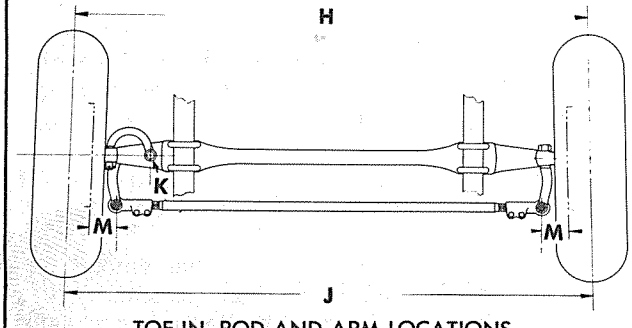
FRONT END ALIGNMENT



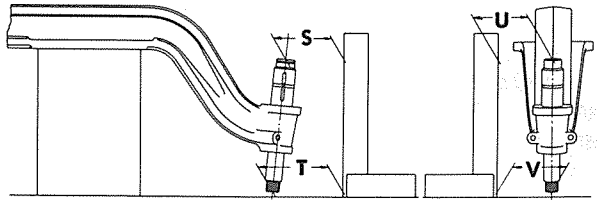
CAMBER, PIN INCLINATION, ARM AND ROD LOCATIONS



FRONT AXLE CASTER



TOE-IN, ROD AND ARM LOCATIONS



AXLE CENTER TWIST AND PIN INCLINATION

B Minus A	Camber (Inches)	K	Relation of Steering Arm to Center of Axle
C	Camber (Degrees)	M	C/L of Tie Rod End to Wheel Rim
D	King Pin Inclination	N	Caster Angle
E	Bottom of Steering Arm Above Axle	P	C/L of King Pin
F	Bottom of Tie Rod Below Spring Seat	R	Vertical
G	Tire Overhang	T Minus S	I-Beam Twist
J Minus H	Toe-in	U Minus V	King Pin Inclination

Refer to "Wheel Alignment Dimensions" for Numerical Values.

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Figure 1—Front End Alignment Chart

checked at the same time.

Where maximum allowable camber exists, wheels should be adjusted for maximum allowable toe-in.

Toe-in is usually measured from centers of tire treads at height of wheel centers (See "J" and "H" on chart). However, toe-in readings can only be obtained accurately with instruments designed for that purpose. Toe-in should always be measured with wheels in straight ahead position.

Before checking toe-in and camber, check wheels for correct installation and check tires for correct air pressure. Wheel installation and tire inflation have a definite bearing on toe-in and camber.

Refer to Wheels and Tires (Sec. 19B of this manual) for instructions pertaining to these items.

If instrument readings indicate necessity of toe-in adjustment, toe-in should be adjusted as directed under "Front Wheel Toe-in Adjustment" in Front Axle (Sec. 1B of this manual).

FRONT END ALIGNMENT

FRONT WHEEL CAMBER

The purpose of camber (See "C" on Chart) is to offset deflection and wear of front axle parts, thus preventing wheels from going into REVERSE camber after long service.

The result of excessive POSITIVE camber is irregular wear of tires on outside shoulders. Excessive positive camber is usually caused by bent parts.

The result of excessive NEGATIVE camber,will be hard steering and possibly a wandering condition. Tires will also wear on inside shoulders. Negative camber is usually caused by excessive wear or looseness of front wheel bearings and steering knuckle bushings, or may be the result of sagging axle. A SAGGING AXLE MAY BE CAUSED BY USE OF HEAT WHEN STRAIGHTENING AXLE CENTER.

The result of UNEQUAL camber may be any or a combination of following condtions: Unstable steering, wandering, kick-back or road shock shimmy, or excessive tire wear. The cause of unequal camber is usually a bent steering knuckle or axle center.

CHECKING CAMBER

Before checking camber, the vehicle should be jacked up at front axle for inspection of wheel bearings and king pins. Excessive looseness of king pins may be checked with a camber gauge attached to wheel. Pull outward at bottom of wheel to take up all slack in wheel bearings and king pins, then take a camber reading. Pull outward at top of wheel and take another reading. If the difference between the two readings exceeds $1/4^{o}$, make following adjustments and checks.

1. Adjust wheel bearings as described in Hubs and Bearings (Sec. 19A of this manual) then take another camber reading as described in preceding paragraphs. If difference is more than $1/4^{o}$, replace steering knuckle bushings and king pins.

2. Check run-out of wheel at rim in manner described in Wheels and Tires (Sec. 19B of this manual). If run-out or wobble is excessive, straighten or replace wheel.

3. Vehicle should be placed on level floor with full weight on wheels to make final camber reading. It is recommended that an accurate camber gauge be used, however, if a camber gauge is not available, readings can be taken as illustrated at "A" and "B" on chart. Place square as shown and measure distance between "A" and rim, and "B" and rim. Lower dimension should exceed upper dimension by amount listed in "Wheel Alignment Dimensions" at end of this section. This dimension on right wheel should not vary over 3/32 from same dimension of left wheel.

4. CAMBER ERROR - An error in final camber reading usually indicates a bent axle center or steering knuckle.

5. To determine whether steering knuckle or axle center is bent, the KING PIN INCLINATION ("D") should be checked. By adding camber to king pin inclination ("C" plus "D"), the INCLUDED ANGLE of steering knuckle is obtained. If there is a difference of $1/2^{o}$ between the included angle of left knuckle and right knuckle, replace the knuckle which is bent.

AXLE CASTER

The purpose of caster (See "N" on Chart) is to provide steering stability which will keep front wheels in a straight ahead position and to assist in bringing wheels out of a turn or curve. When checking caster, it is desired to have not more than 1/2 degree difference between right and left wheels.

The result of NEGATIVE caster is wandering or the vehicle will not come out of turn normally. The cause of negative caster may be sagging or dislocated springs or bent axle center.

Excessive POSITIVE caster will cause front wheel shimmy and will also cause hard steering. Uneven tightening of spring U-bolt nuts will definitely affect caster. Tighten all U-bolt nuts equally and with same degree of effort.

KING PIN INCLINATION

King pins are inclined (See "D" on Chart) to decrease frictional resistance of tires against the road when turning to right or left. Special precision instruments should be used to check king pin inclination; however, a check can be made on bench as shown in chart.

Install king pin bushing on king pin, then rest spring seats on blocks as shown in figure 1. Make check on perfectly level surface. Use square at both ends as shown and measure distance from both ends of king pin (from bushing at upper end) and vertical edge of square (See "V" and "U" on chart). Difference between "U" dimension and "V" dimension is king pin inclination, in inches, and should be same as shown in "Wheel Alignment Dimensions" at end of this section. Axle center twist can also be checked as shown at "S" and "T" on chart.

STEERING GEOMETRY

Steering geometry is the mechanics of keeping front wheels in proper relative alignment as the wheels are turned to extreme right or left. It is sometimes called steering error or steering angularity. The governing factors in steering geometry are the length and angularity of the steering arms and linkage. As a greater part of all driving is done on angle of turns, steering geometry becomes one of the most important factors of front wheel alignment.

Steering error in combination with excessive

FRONT END ALIGNMENT

camber is, briefly, the cause of uneven tire wear. Elimination of this error reduces tendency to skid on turns, eliminates excessive strain on front wheels in turning, improves steering, and decreases tire wear.

It is recommended that special equipment be used to check for steering geometry error.

The following points to check in addition to those previously described are: (See Chart).

1. Relative position of drag link arm to axle spring seat, "E" on chart.
2. Relative position of tie rod to spring seat, "F" on chart.
3. Relative position of steering arm to center line of axle center, "K" on chart.
4. Relative position of tie rod ends to flange plate rim, "M" on chart.

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however, are not supplied by GMC Truck & Coach Division. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

Name	Tool No.
Micro-Liner Set (Wheel Alignment)	TA-1000
Super - Easy Caster Camber Gauge Set	SE-1234

Vendor	Address
Testing Apparatus Company	Detroit, Michigan

WHEEL ALIGNMENT DIMENSIONS

(Refer to Alignment Chart)

B - A = Camber (Inches	3/8 in.
C = Camber (Loose Axle)	$1^{o} \pm 1/4^{o}$
C = Camber (Axle Installed)	$1/2^{o}$
D = King Pin Inclination	5^{o} 30'
E = Drag Link Arm Above Spring Seat	2-3/16 in.
F = Top of Tie Rod Below Spring Seat	1-5/8 in.
J - H = Toe-in	3/16 to 1/4 in.
K = Relation of Drag Link Arm to Axle Center	On Center Line
L = Center of Drag Link Arm to Spring Edge	2-5/8 in.
M = Center of Tie Rod Ball to Flange Plate	1-7/8 in.
N = Caster Angle	1^{o} 35' $\pm 1/2^{o}$ (See Text)
T - S = I Beam Twist	Equal
U - V = Pin Inclination	1-3/32 in.

Front Axle

Contents of This Section

Related Subjects in Other Sections

Front axle assembly used on this vehicle is Reverse Elliott type. Front axle I-beam, steering knuckles and steering knuckle arms are steel drop forgings heat treated to provide extreme toughness and resistance to bending and twisting strains. Wheel bearings and brakes which are carried on front axle are described in their relative sections of this manual. See "Index" above.

Specifications and service data on front axle and associated parts are listed in "Specifications" at end of this section. These limits and specifications should be adhered to whenever periodic inspecitions or maintenance operations are necessary.

STEERING KNUCKLES, KING PINS, AND BUSHINGS

Steering knuckles are provided with large thrust bearings between steering knuckle lower yoke and lower face of front axle I-beam, as shown in figure 1. Since these thrust bearings take vertical thrust loads, up and down movement of steering knuckle on axle center must be kept within proper limits to prevent pounding and consequent breakage of thrust bearings. Use of shims for correcting excessive up and down movement is described later under "Steering Knuckle Installation" in this section.

KING PINS

Tapered king pins are used on all vehicles covered by this manual. Center portion of king pin is tapered to correspond with taper of king pin hole in end of axle center. King pins are retained in steering knuckles with a nut locked in place with a cotter pin. When retaining nut is drawn up tight, tapered portion of king pin mates with taper of hole in axle center thus holding king pin rigidly in axle center.

STEERING KNUCKLE BUSHINGS

As illustrated in figure 1, bushings are used at upper and lower ends of steering knuckles. These bushings are line reamed after assembly to dimensions as listed in "Specifications" at end of this section. Bushings are sealed at upper ends of knuckles by seals held in place with steel retainers. Retainers are held in place by king pin nut. Seal and retainer at lower end of steering knuckle are held in place with a snap ring which fits into groove in king pin.

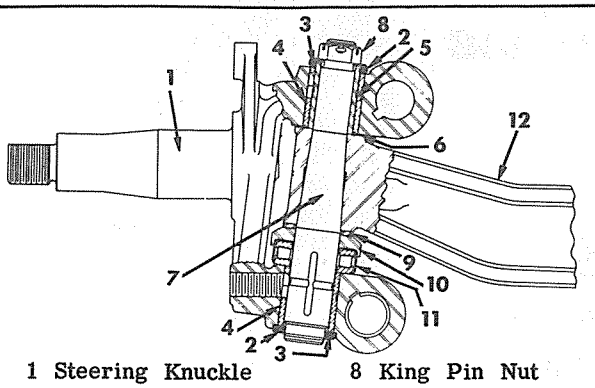
Horizontal and diagonal oil grooves have been machined into inside surface of steering knuckle bushings. These oil grooves index with lubrication fitting hole in bushings, thus insuring thorough lubrication of king pin and steering knuckle.

STEERING KNUCKLE REMOVAL (Fig. 1)

The steering knuckles may be removed from front axle without removing front axle assembly from the vehicle. Before removing the steering knuckles, perform a front end alignment check and other service inspections to determine repairs to be made. Remove steering knuckles from axle in the following manner:

1. Loosen wheel stud nuts then raise front of vehicle with jack.
2. Remove front wheels, then remove hubs and bearings as directed, under "Front Hub and

FRONT AXLE



1 Steering Knuckle
2 Oil Seal Retainer
3 Oil Seal
4 Steering Knuckle Bushing
5 King Pin Bushing
6 Shim
7 King Pin
8 King Pin Nut
9 Thrust Washer
10 Thrust Washer Spacer
11 Thrust Bearing Assembly
12 Axle Center

Figure 1—Steering Knuckle Sectional View

Bearing Removal", in Hubs and Bearings (Sec. 19A, of this manual).

3. Remove front brake shoes as directed under "Front Brake Shoe Removal" in Air Brakes (Sec. 4B, of this manual).

4. Remove nuts and lockwashers from studs which attach brake spider to steering knuckle, then remove brake spider and camshaft as an assembly.

5. Remove brake chambers from brake chamber brackets, then disconnect steering drag link from steering arm, and tie-rod from steering tie-rod arms.

6. Remove cotter pins, nuts, and washers from steering arm and steering tie-rod arms, at steering knuckles; then drive arms out of knuckles using a heavy lead hammer.

7. Remove cotter pin and nut from upper end of king pin then remove seal retainer and seal. Drive king pin out of knuckle from top using a large brass drift, then remove snap ring, seal retainer and oil seal from king pin.

8. Remove steering knuckle, thrust bearing assembly and spacing washer from axle center, then remove king pin bushing from king pin.

CLEANING AND INSPECTION

1. Clean all steering knuckle parts, thoroughly, in clean gasoline or any other suitable cleaning fluid.

2. Inspect thrust bearing assembly for wear or damage. If inspection reveals excessive wear or irreparable damage, replace with new assembly.

3. Check king pin for wear or pitting. Rough spots may be cleaned up with a hone, provided such cleaning does not materially decrease diameter of king pin. Refer to "Specifications", at end of this section, for diameter of new king pin.

4. Check clearance between king pin and king pin bushing and also clearance between steering knuckle bushings and king pin. Clearances greater than those shown in "Specifications", at end of this section, should be corrected by installation of new bushings.

BUSHING REPLACEMENT

If inspection indicates that steering knuckles need rebushing, suitable puller should be used to remove bushings. If such a tool is not available, any coarse thread tap of suitable size can be screwed into bushing and bushing driven out from inside of yoke with rod, preferably brass, slightly smaller than king pin, and long enough to extend about 1-1/2" through opposite side of yoke.

When installing new bushings, round off their edges slightly, and place in position so that oil holes will line up with fitting. Bushings must enter holes straight, when pressed in with vise or arbor press. NEVER ATTEMPT TO DRIVE BUSHINGS IN WITH HAMMER.

Bushings may be reamed with a two step reamer or burnished with burnishing tool. In either case, tool must have long pilot bar or be of sufficient length to burnish both bushings at same time. After bushings are reamed, make sure that oil grooves are cleaned out and all sharp edges in grooves removed.

STEERING KNUCKLE INSTALLATION

When installing steering knuckle, always check up and down movement of knuckle and install shims at top of I-beam if necessary. Install steering knuckles and king pins in the following manner: Key numbers in text refer to figure 1.

1. Press king pin bushing (5) onto king pin (7), making sure bushing is properly aligned with king pin.

2. With steering knuckle (1) in position on axle center (12), install thrust bearing assembly (11), thrust washer spacer (10), and thrust washer (9), as shown in figure 1.

3. Raise knuckle with jack slightly so that weight of front end will rest on thrust bearing and check clearance between top of I-beam and knuckle yoke. Clearance greater than shown in "Specifications," at end of this section should be corrected by installing a shim (6), of suitable thickness, at top of axle center. Shim thicknesses available are given in "Specifications".

4. Make certain king pin hole in axle center (12), king pin (7), and nut (8), are carefully cleaned and dry. King pin nut (8) should screw on king pin freely without binding in any manner. These precautions should be taken to assure king pin being securely locked in place, when installation is completed.

5. Install oil seal retainer spacing washer, oil seal (3), oil seal retainer (2), and oil seal retainer spring on lower end of king pin.

6. Insert king pin (7) through bottom yoke of steering knuckle (1), then drive king pin into place with a lead hammer.

7. Install new oil seal (3), seal retainer (2) and king pin nut (8). Tighten nut with torque wrench (250 to 350 foot pounds torque), then align cotter pin hole in king pin with slots in nut and install new cotter pin full size of hole.

8. Install steering tie rod arms in right and left-hand steering knuckles. Make certain that arm keys are in place when arms are installed. Install and tighten nuts and washers on steering arms firmly; then lock nuts in place with new cotter pins full size of holes. Install drag link steering arm and brake chamber bracket on left hand steering knuckle and brake chamber bracket with bracket stud on right-hand steering knuckle in same manner.

9. Install brake spider. Install camshaft assembly, and brake shoes as directed under "Front Camshaft and Brake Shoe Installation" in Air Brakes (Sec. 4B, in this manual). Adjust and install drag link on steering arm as directed under "Steering Drag Links" in Steering Gear (Sec. 16, in this manual).

10. Install tie-rod as later described in this section. Install and adjust hubs and bearings. Refer to Hubs and Bearings (Sec. 19A, in this manual). Adjust brakes as directed under Brakes (Sec. 4B, in this manual). Install wheels, then check front end alignment as previously described in "Front End Alignment" (Sec. 1A, in this manual).

FRONT AXLE OVERHAUL

FRONT AXLE REMOVAL

1. Loosen wheel nuts, then raise front of vehicle with jack and block vehicle behind front axle.

2. Disconnect drag link from steering arm, then disconnect brake lines from brake chambers.

3. Disconnect shock absorbers and both ends of each front spring as described in "Spring Suspension" (Sec. 15, in this manual) then roll assembly out from under vehicle.

4. Remove bolts which attach each spring assembly to axle, then remove spring assemblies.

5. Remove steering knuckles as previously described under "Steering Knuckle Removal", in this section.

FRONT AXLE INSPECTION

Make certain that parts are carefully cleaned. Inspect axle center, steering arms, knuckles and tie-rod arms, for twisting, bending or distortion. The "Magna Flux" method is recommended for inspecting parts for cracks or fissures that otherwise, would not be visible to the naked eye.

Heat treated parts which have become bent or twisted more than 5^{o} from original shape, should be replaced with new parts.

When parts are bent or twisted beyond 5^{o} from original form, they are generally twisted beyond their original material elasticity limits. Minute fractures hardly visible, usually occur and these fractures may cause failures under ordinary conditions.

STRAIGHTENING FRONT AXLE

The straightening of twisted front axle forgings MUST be performed only by mechanics thoroughly familiar with such operations, and experienced in the use of special straightening tools.

Heat weakens the original structural qualities of these parts.

Always Straighten Front Axle Forgings Cold- The practice of applying heat to front axle forgings should be discouraged - Under No Conditions Should Heat Be Applied When Straightening These Parts.

FRONT AXLE INSTALLATION

1. Install steering knuckles as previously described under "Steering Knuckle Installation" in this section.

2. Position and install front springs on front axle. Then roll axle assembly under vehicle and attach springs and shock absorbers as directed under "Spring Installation" in Spring Suspension (Sec. 15, in this manual).

3. Connect brake air lines to brake chambers. Install drag link in steering arm. Adjust hub bearings as directed in Hubs and Bearings (Sec. 19A, in this manual), then check brake adjustment as directed in Air Brakes (Sec. 4B, in this manual).

4. Remove blocks which support vehicle, tighten wheel nuts, and check tightness of bolts which attach springs to axle; then check front wheel alignment as directed in Front End Alignment (Sec. 1A, in this manual).

FRONT AXLE

STOP SCREWS

Adjustable stop screws at front axle steering knuckles limit turning angle of front wheels. These stop screws, when correctly adjusted, prevent tire interference with body or chassis.

Adjustment of stop screws is an important operation. If stop screws are adjusted to provide excessive clearance, difficulty may be experienced when making sharp turns. If insufficient clearance exists, tires may contact some point on chassis when turning.

Stop screw should be adjusted to permit not less than 1/2 inch clearance between extreme portion of tire and closest chassis point when wheels are turned to extreme right or left.

ADJUSTMENTS

Note: Pitman arm must be assembled to gear in correct position and steering drag link must be properly adjusted before any attempt is made to adjust stop screws. Refer to Steering Gear (Sec. 16, in this manual), for drag link and Pitman arm adjustment procedures. Adjust stop screws in the following manner:

1. Raise front of vehicle and disconnect steering drag link at Pitman arm.

2. Turn steering wheel and vehicle wheels to extreme right position. Adjust right steering knuckle stop screw until stud hole in Pitman arm is not more than 1/4 inch to rear of drag link stud - or so it is necessary to back Pitman arm not less than 3/4 inch toward straight-ahead position to fit drag link stud into hole in Pitman arm. If tires have less than 1/2 inch clearance from closest chassis obstruction, adjust stop screw until this clearance is obtained.

4. Turn steering wheel and vehicle wheels to extreme left-hand position. Adjust steering knuckle stop screw until stud hole in Pitman arm is not more than 3/4 inch ahead of drag link stud or so it is necessary to move Pitman arm not more than 3/4 inch toward straight-ahead position to fit drag link stud into hole in Pitman arm. If tires have less than 1/2 inch clearance from closest vehicle obstruction, adjust stop screw until this clearance is obtained.

5. Install drag link on Pitman arm and lower front of vehicle to floor.

TIE ROD

Tie rod assembly used is three-piece type comprised of a rod and two end assemblies. Tube is threaded into ends and locked with clamp bolts. Right and left-hand threads are provided on tie rod to facilitate toe-in adjustment.

The stud is held against a bearing cup by a seat and spring. An end plug, secured in place with a lock ring, maintains the parts in correct relative position as shown in figure 2.

MAINTENANCE

Do not permit stud to work loose, or holes in steering tie-rod arms may become enlarged as a result of excessive play. Subsequent tightening of stud nuts may draw studs into steering arms so far, that springs and dust covers may become damaged while turning to extreme right or left.

Normal wear on bearing surface in tie rod end, will cause increase in overall height of assembly. If excessive play is noted, it is evident that worn parts, or complete end assembly must be replaced.

TIE ROD END REPAIR

When it is evident that excessive wear necessitates repairing the tie rod ends, repairs are accomplished in the following order:

REMOVAL AND DISASSEMBLY (Fig. 2)

1. Disconnect tie rod end from steering tie-rod arm. Loosen clamp bolt nuts then remove tie rod end from tie rod.

2. Remove outer dust seal cover (14), outer dust seal (13), inner dust seal cover (12), and inner dust seal (11) from end stud (2).

3. Pry end plug lock (7) out of tie-rod end (4), then remove end plug (6), end stud seat spring (5), end stud seat (9), grease retainer (8), end stud (2), end stud bearing (3), and end stud bearing seat (10) from tie-rod end.

CLEANING AND INSPECTION

Immerse all parts except dust seal covers (12 and 14) in cleaner use a stiff bristle brush as required, and clean parts thoroughly. If any parts show evidence of wear or corrosion, install new parts. Check tension of spring, if tension of spring is not within limits listed in "Specifications" at end of this section, install new spring.

Carefully inspect rollers in end stud bearing assembly for roughness or flaking. If rollers will not rotate freely in retainer, bearing assembly should be replaced.

ASSEMBLY AND INSTALLATION (Fig. 2)

1. Lubricate parts with lubricant specified in Lubrication (Sec. 13, in this manual), then place end stud bearing (3) and end stud bearing seat (10) on end stud (2).

2. Insert stud and bearing assembly into tie-rod end (4), then press grease retainer (8) over end of end stud seat (9).

3. Place stud seat in tie-rod end (4) then install end stud seat spring (5) and end plug (6). Secure all parts in tie-rod end (4) with end plug lock (7).

4. Install on threaded end of stud, in the following order, inner dust seal (11), inner dust seal cover (12), outer dust seal (13), and outer dust seal cover (14).

5. Install tie rod end assembly on tie rod tube; then install stud on steering tie-rod arm. Install clamp bolts, new lock washers and nuts but do not tighten nuts at this time.

6. Adjust toe-in as directed later in this section. After toe-in adjustment has been completed, tighten both clamp bolt nuts firmly and lubricate tie-rod ends as specified in Lubrication (Sec. 13, in this manual).

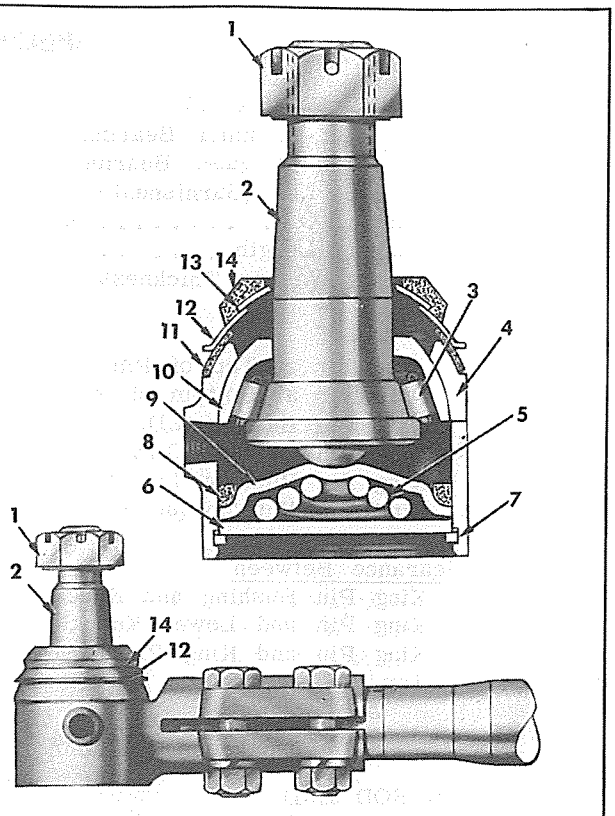


Figure 2—Tie Rod End Sectional View

FRONT WHEEL TOE-IN ADJUSTMENT

Loosen two clamp bolts at each end of tie rod and turn tie rod with wrench until correct toe-in is obtained. Opposite ends of tie-rods should be in same plane before clamp bolts are tightend. After clamp bolts are tightened, tie-rod ends must not bind in steering arms when wheels are turned to extreme right or left.

Tie rod ends should be lubricated at intervals shown in Lubrication (Sec. 13, in this manual).

IMPORTANT

A careful inspection of front axle parts is important, particularly after a severe curb bump or collision.

FRONT AXLE

SPECIFICATIONS

STEERING KNUCKLES	
Diameter at Inner Bearing	2.5613 - 2.5623 in.
Diameter at Outer Bearing	2.1243 - 2.1248 in.
Bushing I.D. (Burnished)	1.717 - 1.718 in.
Bushing O.D.	2.132 - 2.128 in.
Bushing Length	2-11/64 in.
Thrust Washer Thickness	0.150 - 0.160 in.
KING PIN	
Diameter at Top of Pin	1.309 - 1.310 in.
Diameter at Bottom of Pin	1.716 - 1.717 in.
King Pin Bushing I.D.	1.310 - 1.311 in.
King Pin Bushing O.D.	1.7155 - 1.7165 in.
King Pin Bushing Length	2-1/2 in.
King Pin Nut Torque - Minimum	250 ft. lbs.
Clearance Between	
King Pin Bushing and Knuckle Bushing	0.0005 - 0.0025 in.
King Pin and Lower Knuckle Bushing	0.000 - 0.002 in.
King Pin and King Pin Bushing	0.000 - 0.002 in.
Top of Axle Center and Steering Knuckle	0.015 in. Max.
Adjustment	Shims
Shim Thickness Available	0.010 and 0.020 in.
TIE ROD END	
End Stud Seat Spring	
Free Length	3/4 in.
Solid Height	27/64 in.
Compressed to 1/2 in.	350-400 lbs.
AXLE CENTER (I-BEAM)	
Twist: Allowable Variation Between Ends	$1/2^{o}$
Spring Centers	42 in.

Rear Axle — Early Type

Contents of This Section

Related Subjects in Other Sections

Rear axle is full floating type. One-piece axle housing has spring pads integral with housing and housing bowl is offset toward right side of vehicle. Drive pinion assembly is mounted at an angle as later illustrated in figure 1. Drive is transmitted from transmission angle drive unit through propeller shaft, spiral bevel, axle housing, and springs to vehicle underframe. Differential and pinion shaft assemblies both incorporate adjustments for bearings and gear tooth contact.

CONSTRUCTION

DIFFERENTIAL CARRIER

Differential assembly, pinion shaft and cage assembly, are mounted in differential carrier. After axle shafts have been removed, and propeller shaft has been disconnected, differential carrier can be removed for inspection and adjustment without removing axle housing from vehicle.

DIFFERENTIAL ASSEMBLY

Conventional four-pinion type differential is carried in two-piece case mounted on tapered roller bearings. Bevel drive gear is bolted to flange half of differential case. Drive gear and pinion are furnished in matched lapped sets and should always be installed as such to assure satisfactory operation.

Thrust washers are used between differential side gears and case and differential pinions and case. Each pinion contains an aluminum bronze bushing. When bushings become worn, pinions must be replaced. Differential case halves are held together with special bolts and castellated nuts, locked in place with lock wire.

DIFFERENTIAL SIDE BEARINGS

Differential case is supported in tapered roller bearings which take thrust as well as radial loads. Bearings are mounted in machined supports in differential carrier with thrust loads taken against adjusting rings threaded into carrier supports and bearing caps. Adjusting rings bear against bearing cups and are locked in position by adjusting ring locks bolted to each bearing cap.

DRIVE PINION AND CAGE ASSEMBLY

Drive pinion is straddle mounted in two opposed tapered roller bearings at outer end, and one straight roller bearing at inner end. Tapered roller bearing cups are installed in a pinion cage as shown in figure 1 and are separated by a machined shoulder in cage. Bearing cones are assembled on pinion shaft and are adjusted on shaft by adjusting nut and thrust washer. Bearing at inner end of pinion is pressed on stub end of shaft and secured in place by retainer and bolt.

Shims of various thicknesses are used between bearing cage and differential carrier to adjust drive pinion tooth contact.

Pinion shaft and cage assembly cannot be removed from carrier until differential case assembly including drive gear has been removed from carrier.

AXLE SHAFTS AND HOUSING

Axle shafts are full floating type. Drive flange at outer ends have external teeth which mesh with

REAR AXLE (EARLY TYPE)

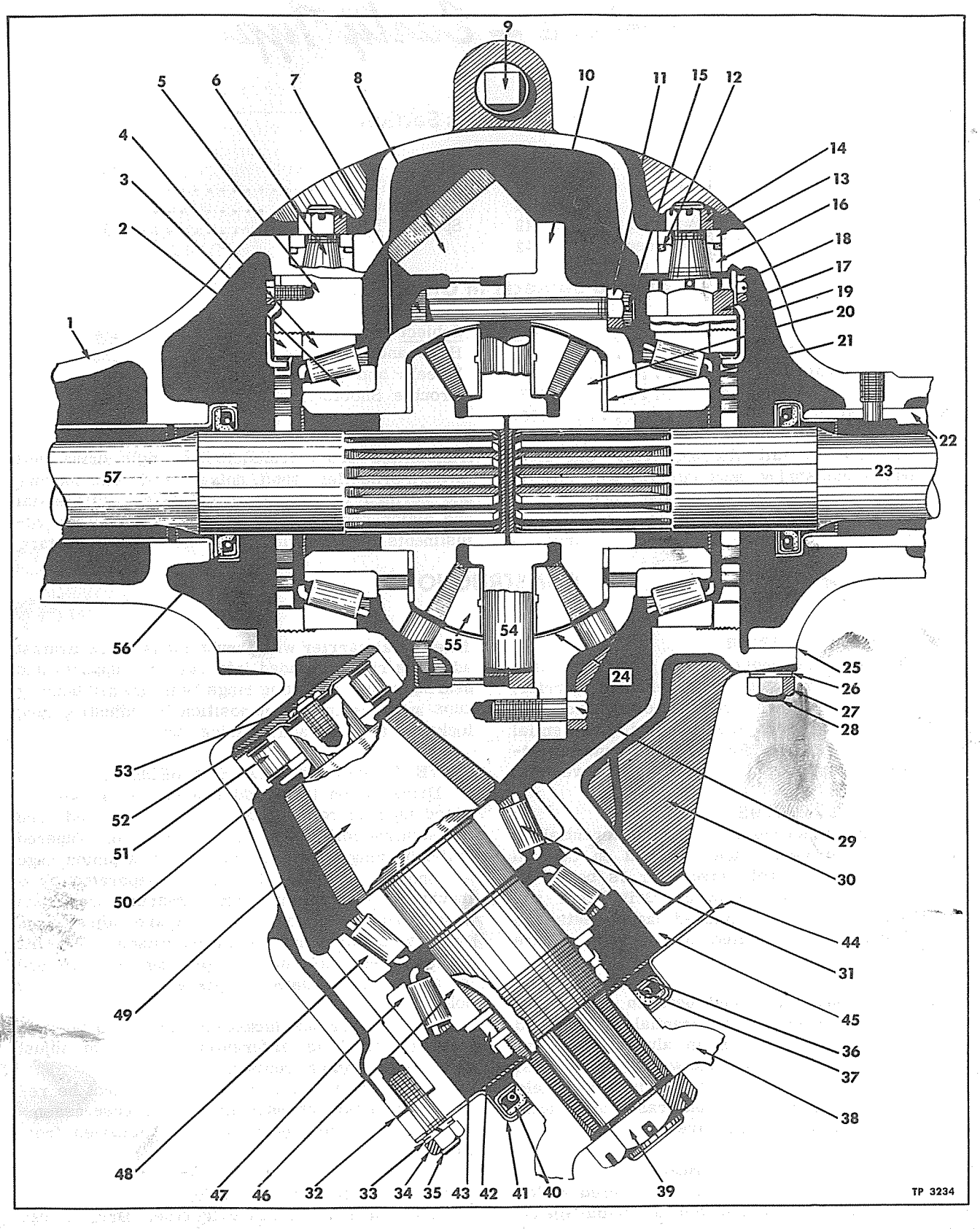


Figure 1—Cross Section View of Rear Axle

REAR AXLE (EARLY TYPE)

1 Axle Housing
2 Adjusting Ring
3 Differential Side Bearing Cone
4 Differential Side Bearing Cup
5 Differential Bearing Cap
6 Differential Bearing Cap Support Stud
7 Differential Case Bolt
8 Bevel Drive Gear (Matched)
9 Filler Plug
10 Differential Case
11 Differential Case Bolt Nut
12 Support Bushing Gasket
13 Support Stud Washer
14 Support Stud Nut
15 Lock Wire
16 Support Stud Bushing
17 Differential Bearing Cap Stud Nut
18 Adjusting Ring Lock Bolt
19 Adjusting Ring Lock
20 Differential Side Gear
21 Differential Side Gear Thrust Washer
22 Housing Outer End Tube
23 Axle Shaft (Right Hand)
24 Differential Pinion Thrust Washer
25 Differential Carrier Gasket
26 Lock Washer
27 Differential Carrier Stud Nut
28 Differential Carrier Stud
29 Drive Gear Bolt
30 Differential Carrier Assembly
31 Inner Drive Pinion Bearing (Tapered Roller)
32 Drive Pinion Cage Shims
33 Lock Washer
34 Stud Nut
35 Drive Pinion Cage Stud
36 Adjusting Nut Lock
37 Drive Pinion Lock Nut
38 Universal Joint Flange
39 Drive Pinion Nut
40 Oil Seal
41 Drive Pinion Bearing Cover
42 Adjusting Nut
43 Thrust Washer
44 Drive Pinion Bearing Cover Gasket
45 Drive Pinion Bearing Cage
46 Outer Drive Pinion Bearing Cone (Tapered Roller)
47 Outer Drive Pinion Bearing Cup
48 Inner Drive Pinion Bearing Cup
49 Drive Pinion (Matched)
50 Bearing Spacer
51 Inner Drive Pinion Bearing (Straight Roller)
52 Bearing Retainer
53 Bearing Retainer Bolt
54 Differential Spider
55 Differential Pinion
56 Inner Axle Shaft Oil Seal Assembly
57 Axle Shaft (Left-Hand)

TP 3234 B

Captions For Figure 1

similar internal teeth on hub drive plate. Drive plate is doweled to hub with dowel pins and held in place together with plate cover with ten hub studs and nuts as later shown in figure 8.

Axle housing is one-piece design with differential located off center. Housing is equipped with removable outer end tubes which are threaded to accommodate wheel bearing adjusting nuts.

AXLE MAINTENANCE ON VEHICLE

At regular intervals, the rear axle should be inspected as follows:

1. Axle Shaft Cover Stud Nuts. Examine stud nuts and studs which secure drive plate covers on hubs for looseness and tighten nuts firmly if necessary. Use new lock washers under nuts if required.

2. Lubricant Leaks. Check pinion shaft oil seal and cover gasket, axle shaft plate and cover gaskets, and differential carrier gasket for leaks. Correct leaks by tightening bolts and stud nuts, or by replacing gaskets or oil seals.

3. U-Bolts. Check and tighten spring bolts. Examine axle for misalignment. This can be done by measuring from rear spring front bracket bolt to end of axle. A measurement taken between identical points at opposite end of axle should be the same as first measurement, if axle is properly aligned.

4. Axle Housing Check. If bent axle housing is suspected, check as directed under "Axle Repair" later in this section.

5. Lubricant. Check lubricant level at regular intervals. Add lubricant as required. Refer to Lubrication (Sec. 13, in this manual), for correct type of differential lubricant.

Housing should be kept filled to level of filler plug. Drain plug is at lowest point of housing.

REAR AXLE (EARLY TYPE)

AXLE SHAFT REPLACEMENT

AXLE SHAFT REMOVAL

1. Remove outer drive plate cover, cover spring and gasket. Insert 1/2"-13 cap screw in tapped hole in axle flange. Screw should be long enough to pull axle flange free from drive plate teeth. Withdraw axle shaft from housing.

2. If it is necessary to remove drive plate, do not remove axle shaft. Instead, use a suitable puller which will exert pressure on flange and may be attached to drive plate with three 1/2"-13 cap screws of sufficient length so drive plate teeth will clear flange teeth.

AXLE SHAFT INSTALLATION

1. Before axle shafts are installed, ascertain that hub bearings are in proper adjustment; then insert drive plate dowel pins into place. Three gaskets are used at flange end of each axle. Namely, between hub and drive ring, drive plate and drive ring, and between drive plate and plate cover.

2. Install over end of hub studs in sequence, gasket, drive ring, gasket and drive plate; then dip splined end of axle shaft in differential lubricant and insert shaft into hub. Align shaft splines with side gear splines, and flange teeth with drive plate teeth; then push shaft into place and install cover gasket. Make certain the small spring between drive plate cover and shaft flange is located correctly on bosses of flange and cover.

3. Install nuts and new lockwashers on studs; then tighten nuts alternately and firmly.

AXLE ASSEMBLY REPLACEMENT

AXLE ASSEMBLY REMOVAL

1. Remove drain plug and drain lubricant from axle housing. Loosen wheel stud nuts until nuts are finger tight.

2. Place jacks under axle housing, then raise vehicle. When rear of vehicle is supported with blocks placed in front of rear axle and jacks are removed, wheels should clear floor.

3. Remove jacks after blocks are securely in place under vehicle. Remove rear wheel stud nuts, then remove wheels.

4. Disconnect brake air lines at brake chambers.

5. Disconnect propeller shaft slip joint dust seal cap. Refer to Propeller Shaft (Sec. 18, of this manual), for complete information on propeller shaft removal.

6. Loosen spring U-bolt nuts until nuts are finger tight.

7. Place a suitable dolly jack under axle housing. Be sure axle is cradled securely and properly balanced on jack. Raise axle assembly sufficiently to take weight of axle off springs.

8. Remove spring bracket side plates at rear end of both rear springs. Refer to Spring Suspension (Sec. 15, of this manual). Lower axle permitting springs to pivot on front shackle pins.

9. Remove spring U-bolts to free axle from springs.

10. Remove axle assembly by pulling dolly jack, supporting axle, out from under rear end of vehicle. Rear springs need not be removed from vehicle.

AXLE ASSEMBLY INSTALLATION

1. Carefully check, inspect and replace, as necessary, parts in propeller shaft universal joints, rear spring mountings, wheels and rear hubs. Each of these items is covered in detail, in its respective section elsewhere in this manual.

2. With rear axle completely assembled and supported on dolly jack, roll assembly into place under vehicle. Assemble propeller shaft slip joint. Align axle as required to accomplish assembly. Arrow markings on propeller shaft must be in alignment to assure assembling of universal joints in proper plane and balance. Refer to Propeller Shafts (Sec. 18, of this manual).

3. Position axle housing on springs and align center bolt head in recess provided in housing for center bolt. Position U-bolt spacer on top of housing, then install U-bolts on spacer and housing. Place spring retainer plate over ends of U-bolts and install nuts on U-bolts, finger tight.

4. Raise axle housing and align rear ends of spring in position. Install spring brackets as directed in Spring Suspension (Sec. 15, of this manual).

5. Lower dolly jack, then tighten U-bolt nuts firmly.

6. Connect brake air lines at brake chambers, refer to Brakes (Sec. 4B, of this manual).

7. Install rear wheels and tighten stud nuts. Refer to Wheels and Tires (Sec. 19B, of this manual).

8. Raise dolly jack under axle housing sufficiently to remove blocks which support vehicle, then lower jack and remove from under vehicle.

9. Be sure that axle housing is filled to correct level with proper lubricant and filler plug installed. Refer to Lubrication (Sec. 13, of this manual).

REAR AXLE REPAIR

The following instructions provide procedures for removal, complete disassembly, cleaning, inspection, repair and assembly of rear axle.

Axle shafts and differential carrier assembly may be removed from axle housing for repair or replacement without removing entire axle assembly from the vehicle. For a complete inspection and rebuilding of the entire assembly, it is recommended that rear axle be removed from the vehicle.

AXLE HOUSING CHECK (Before Removal)

At regular intervals, or when it is suspected that rear axle is bent, a check should be made by the following method. This check can be made before the axle assembly is removed from the vehicle, and in that manner determine the extent of repairs required. The check is made with conventional front end alignment camber and toe-in equipment.

1. Check hub bearing adjustment and adjust bearings if required. Refer to Hubs and Bearings (Sec. 19A of this manual). Check rear wheels for run-out or "wobble" in the following manner:

a. Place vehicle on smooth level floor; then raise rear axle with a jack and place supports under each side of axle housing.

b. Make certain that wheels are mounted solidly on hubs and that wheel nuts are tightened firmly. Position a spring type scriber or marker (same type used to mark center of tire treads when checking front end alignment), at right angle to rear outside wheel rim. Point of scribe should be placed 1/8" away from wheel rim.

c. Revolve wheel slowly, and at the same time, note if rim of wheel contacts point of scriber or, if gap between scriber point and rim increases or diminshes. If run-out exceeds 3/32 inch (new limits), wheel should be replaced with one that does not exceed new limits. Perform check on both rear wheels.

2. Lower wheels to floor. Place a conventional camber gauge on rim of wheel. Note reading, if reading exceeds 0 degree, plus or minus 1/4 degree, axle housing is bent on that side. Repeat check on opposite wheel and note reading on camber gauge. If reading exceeds 0 degree, plus or minus 1/4 degree, that side is also bent.

3. Place a conventional toe-in gauge between inner tires in front of rear axle under vehicle close to bottom side of springs. Note reading at each end of instrument; then carefully roll vehicle forward until instrument is close to bottom side of springs at rear of vehicle. Again note readings at ends of instrument, if second reading exceeds the first by more than 1/4 degree, the side (right or left) of the axle on which the variation exists, is bent forward or backward as denoted by the reading.

AXLE DISASSEMBLY

(Key Numbers in Test Refer to Fig. 1)

Before and during disassembly operations, a preliminary inspection and check of all adjustments should be made to determine repairs required. Perform these procedures in order given.

1. Perform a visual check on the exterior of axle housing for leaks, damage, cracks, etc., which are usually detected before axle housing is cleaned. Note all evident conditions to assist in the repair of axle assembly. After inspection is completed, clean exterior of axle housing thoroughly with a suitable cleaning fluid and a stiff bristled brush, or use steam cleaning.

2. Check drive gear and pinion backlash.

3. Check pinion depth in dirve gear and note if excessive end play exists in pinion bearings.

4. Check each bolt which is used to attach drive gear to differential case flange for looseness. Check drive gear run-out before removing differential case assembly from carrier.

DIFFERENTIAL CARRIER REMOVAL
(Key Numbers in Text Refer to Fig. 1)

1. Remove axle shafts as previously instructed under "Axle Shaft Replacement" in this section.

2. Remove drain plug and drain lubricant from housing while loosening differential carrier stud nuts. Place suitable dolly jack under differential carrier to support during removal.

3. Remove nuts (14) and washers (13), from bearing cap support studs (6). Remove nuts (27) and lock washers (26), from differential carrier studs (28); then pull differential carrier as assembly out of axle housing.

4. Remove bushings (16) and gaskets (12). Be particularly careful that none of these parts drop into axle housing and remain there.

DIFFERENTIAL CASE REMOVAL

1. Remove lock wire from bolts (18) which secure locks (19). Mark bearing caps (5) and differential carrier (30) so caps (5) may be installed in the same relative position.

2. Remove nuts (17) from bearing cap studs (6), then remove bearing caps (5), rings (2), and lift differential assembly including cups (4), gear (8) and side bearings (3) out of carrier.

DIFFERENTIAL CASE DISASSEMBLY (Fig. 1)

1. Use CS-1047 puller (fig. 2) to remove bearing cones which are pressed on hubs. This

REAR AXLE (EARLY TYPE)

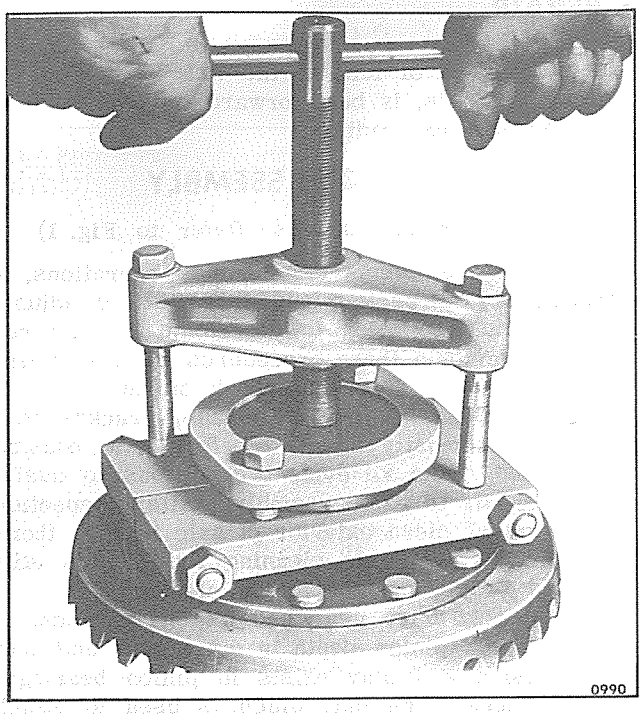


Figure 2—Removal of Differential Side Bearings (Tool No. CS-1047)

completely removes side bearings (2).

2. Before disassembling differential case (10) be sure both sections are marked (fig. 3), so parts can be assembled in same relative position.

3. Cut lock wire (15) and remove nuts (11) from bolts (7), then pull case sections (10) apart. Remove bolts (29) from bevel gear (8), then remove gear (8) from case flange.

4. Remaining parts of differential can now be removed from case (10). These parts are thrust washers (21 and 24), side gears (20), pinion gears (55) and spider (54).

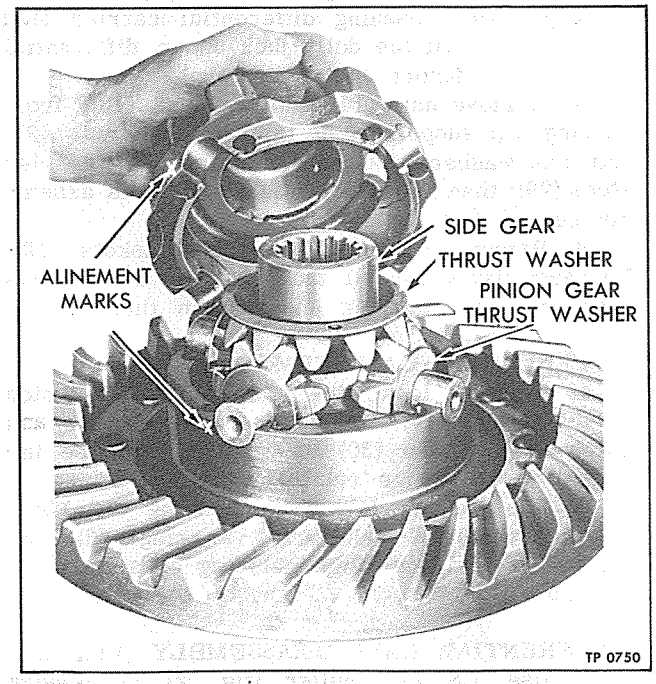


Figure 3—Typical Differential Case Showing Alignment Marks

DRIVE PINION CAGE REMOVAL AND DISASSEMBLY (Fig. 1)

After differential assembly has been removed from carrier (30), drive pinion (49) and pinion cage assembly (45) are removed and disassembled in the following manner:

1. Mark pinion cage (45) and differential carrier (30) in a suitable manner with hammer and chisel so parts may be reassembled in same relative position.

2. Remove nuts (34) and lock washers (33) from studs (35). Install and tighten puller screws alternately until pinion cage (45), bearing and drive pinion assembly are free in carrier (30); then remove cage (45) assembly from carrier (30). Remove and tie shim (32) pack together to retain original shim pack to be installed at reassembly.

3. Remove bolt (53) and retainer (52) which secure inner bearing (51) on drive pinion (49); then remove inner bearing (51) and bearing spacer (50) from drive pinion (49).

4. Clamp flange (38) in a vise. Remove cotter pin and nut (39) from drive pinion (49). Remove flange (38), cover (41) and oil seal (41) assembly, and gasket (54) from cage.

5. Pry nut lock (36) lip away from lock nut (37); then remove lock nut (37), (fig. 4) nut lock (36), adjusting nut (42) and thrust washer (43), from drive pinion (49).

6. Position drive pinion and cage assembly in an arbor press and press drive pinion (49) out of pinion cage (45) and outer bearing (46). Remove outer bearing (46) from pinion cage (45). Use special bearing puller CS-1047, to remove inner bearing (31) from drive pinion (49).

7. Bearing cups (47 and 48) may be removed (if necessary) from pinion cage (46) with a brass drift and hammer.

CLEANING, INSPECTION, AND REPAIR

Cleaning Bearings

1. Immerse differential and drive pinion bearings in gasoline, kerosene, or other suitable cleaning fluid. Leave bearings in fluid long enough so fluid will dissolve and loosen old lubricant. After bearings have been soaked in fluid a sufficient length of time, bearings should be alternately slushed up and down and spun slowly below the surface of liquid to remove old lubricant.

2. Remove bearing from fluid, then strike large side of bearing flat against wooden block to jar loose heavy and larger particles of lubricant, Repeat until bearings are thoroughly clean.

3. Rinse bearings out in clean fluid, then blow bearings dry with compressed air. CAUTION: Do not spin bearings while blowing them dry with compressed air. After bearings have been inspected as later described in this section of the manual, and bearings are going to be used, dip bearings in differential lubricant recommended in Lubrication (Sec. 13, in this manual), and wrap in clean cloth or paper until needed.

Cleaning Parts

1. Immerse all parts in suitable cleaning fluid and clean parts thoroughly. Use a stiff bristle brush as required to assure removal of any accumulation of old lubricant, etc., which may be evident. Remove particles of gaskets which may adhere to mating faces of axle housing, differential carrier, cover oil seal retainer, hubs and axle shaft flanges. Clean lubricant channels in pinion cage and differential carrier as required. Clean breather type screw. Make certain that axle housing is thoroughly cleaned.

INSPECTION

Whenever available, the Magna Flux Method should be used on all steel parts, except ball and roller bearing. This method is especially suited for inspection of ground or highly finished surfaces for wear and cracks which otherwise would not be visible to the naked eye.

Inspection Operations

1. Bearings. Rotate each bearing slowly, and at the same time examine bearing for roughness, damage, defects, or wear, Note condition of bearing cage and replace bearing if cage is damaged or if any of the conditions previously noted are evident.

2. Gears. Examine drive gear and drive pinion, differential side gears closely for damaged teeth, worn spots in surface hardening and distortion. Examine bushings in differential pinions for grooves, or excessive wear and check fit of gears on spider. Refer to "Specifications" later in this section for limits. Inspect drive gear rivets for looseness, replace loose rivets. Check radial clearances between differential side gears and differential pinions on spider. Refer to "Specifications" at end of this section for limits.

3. Differential Case. Inspect differential case assembly for cracks, distortion or damage, if case is in good condition, thoroughly clean case and cover; then assemble case with bolt and mount in lathe centers or "V" block stand. If lathe

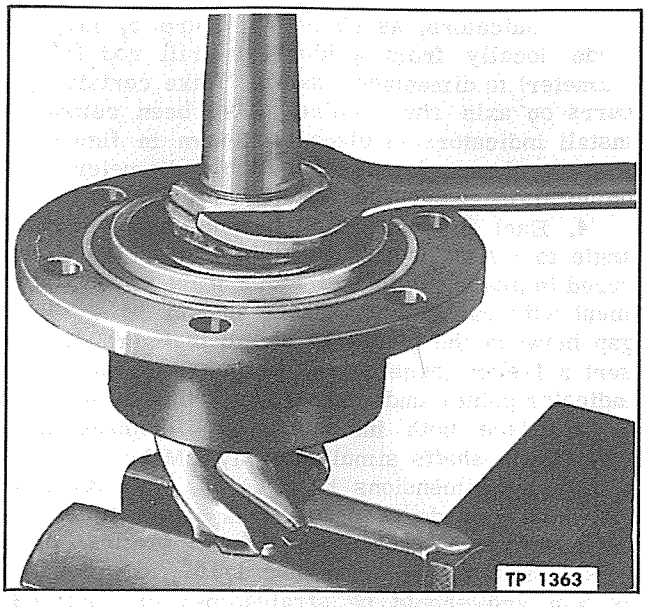


Figure 4—Drive Pinion Cage Disassembly

is not available, install differential side bearings and mount case in differential carrier as directed under "Differential and Drive Gear Installation" later in this section. Install dial indicator and check differential case run-out. Refer to "Specifications" at end of this section, for run-out limits. Whenever run-out exceeds limits differential case run-out may be corrected as later described under "Repair" in this section.

4. Axle Shafts. Examine splined end of axle shaft for twisted or cracked splines, twisted shaft, and worn dowel holes in flange. If any of above conditions are evident, install new shaft.

5. Axle Shaft and Flange Run-out. Install axle shaft assembly in lathe centers or "V" blocks and check shaft run-out with dial indicator, if run-out exceeds limits listed under "Specifications" at end of this section, discard axle shaft. Position dial indicator so that indicator shaft end contacts inner surface of flange near outer edge of flange and check flange run-out. Whenever run-out exceeds limits listed under "Specifications" at end of this section, discard axle shaft.

Axle Housing Inspection

1. Thoroughly clean inside of housing as well as outer ends. Temporarily install wheel hubs. Refer to Hubs and Bearings (Sec. 19A, of this manual), and Lubrication (Sec. 13, of this manual).

2. Adjust wheel bearing nuts so that hubs will just turn; however, do not lock adjustment at this time. Install axle shafts, dowels and nuts; then tighten nuts firmly. NOTE: Axle shafts should be inspected as previously described under "Inspection Operations" in this section, before installation.

REAR AXLE (EARLY TYPE)

3. Indicators, as shown in figure 5, may be made locally from welding or drill rod (3/16" diameter) to dimensions shown. Make certain that burrs on axle shaft splines have been removed. Install indicators in place as shown in figure 5. Radiator hose clamps of suitable diameter may be used to secure indicators in position.

4. Each indicator must be positioned at right angle to its respective axle shaft after it is secured in place. Both indicators must be in alignment with each other. There should be a slight gap between the points as shown in figure 5. Insert a feeler gauge or measure gap between the indicator points, and make note of this dimension.

5. Place both indicators in alignment, then rotate both shafts simultaneously. Make a check of the gap dimensions between the indicators at four points 90 degrees apart, as shown in figure 5. If the gap at each point exceeds original predetermined gap by more than 1/16", axle housing is bent and should be straightened or replaced.

Oil Seal Inspection

Replacement of spring loaded oil seals whenever unit is disassembled is more economical than premature overhaul to replace these parts at a future time. Further, loss of lubricant through a worn seal may result in failure of other parts, such as gears and bearings.

Handle seals carefully, particularly when seals are being installed. Cutting, scratching or curling under of lip of seal seriously impairs efficiency of seal. Use of Permatex or equivalent around outer diameter of seal is recommended to insure against leakage at that point.

REPAIR

Differential Case. Excessive run-out on differential case may be corrected by machining flange on gear side of case. Remove sufficient metal from gear face of flange on differential case to correct excessive run-out. The metal must be cut on a true plane removing just enough metal to bring run-out within limits listed under "Specifications" at end of section. After differential case has been machined, remove burrs and clean case assembly thoroughly.

Propeller Shaft Flange. Whenever inspection indicates that exterior surface of flange which contacts oil seal is corroded or pitted, the condition may be corrected by cleaning and polishing surface with a suitable abrasive cloth. If cleaning and polishing surface of flange does not clear up the condition, discard flange and install new parts.

REASSEMBLY

(Key Numbers in Text Refer to Fig. 1)

Before the axle is reassembled, make certain that all parts have been thoroughly cleaned, and that a thin coating of differential lubricant speci-

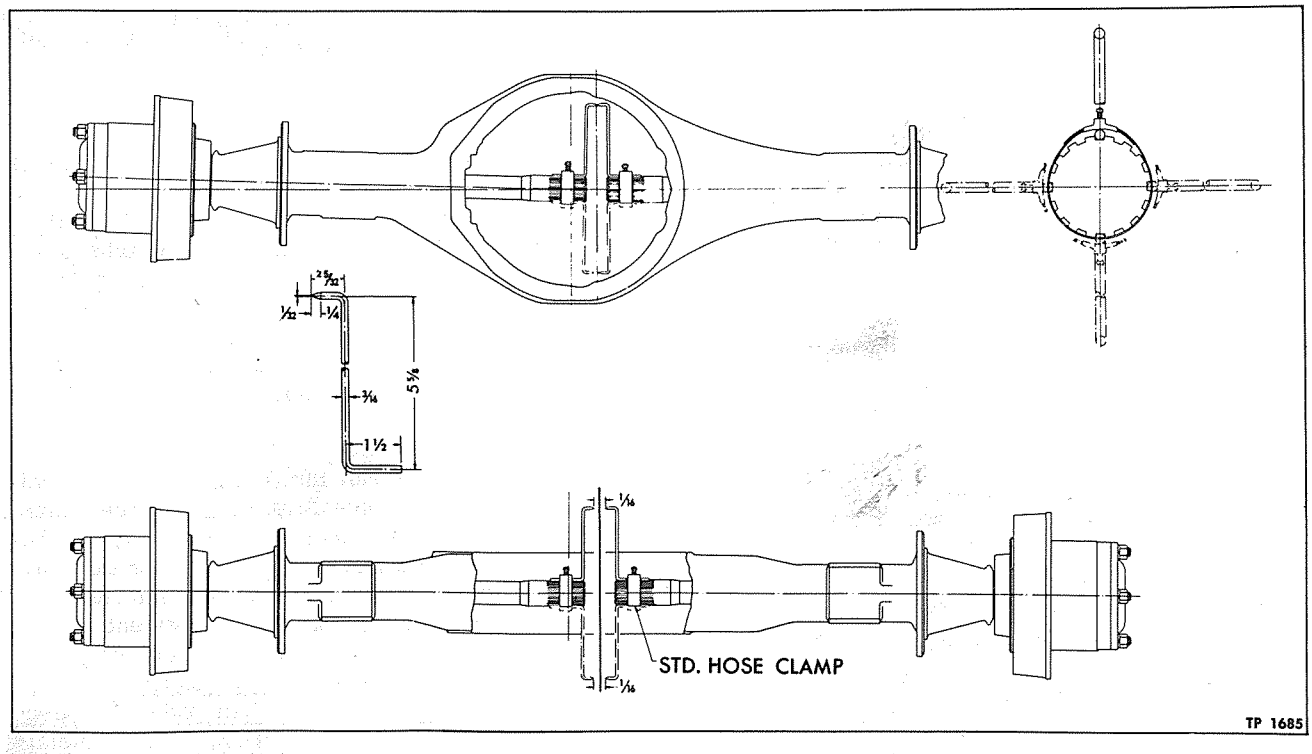


Figure 5—Housing Alignment Check

fied in Lubrication (Sec. 13, in this manual), is applied on all thrust and bearing surfaces to prevent scoring of parts when vehicle is first placed in service.

New lock washers, gaskets, and oil seals are recommended throughout during reassembly of axle. Make certain that all threads on bolts, screws, etc., are in good condition before they are installed.

Adjustments must be carefully made to insure efficient and continuous operation.

DRIVE PINION AND CAGE REASSEMBLY
(Key Numbers in Text Refer to Fig. 1)

Note relative position of bearing parts as previously shown in figure 1. Make certain that bearings are assembled to conform to figure 1.

1. Press bearing cups (47 and 48) into pinion cage (45), if bearing cups were removed during disassembly.

2. Install bearing (31) on drive pinion (49) with widest portion of bearing (31) toward heel of gear teeth (49). Make certain that bearing bottoms solidly against teeth of drive pinion (49).

3. Secure inner end of drive pinion (49) in vise equipped with padded jaws. Position cage (45) over splined end of drive pinion (49); then install bearing (46) in cage (45).

4. Install washer (43) on top of bearing (46) screw adjusting nut (42) on top of washer; then tighten adjusting nut (42) until there is not perceptible end play evident. Test adjustment with torque wrench as shown in figure 6. If torque resistance is less than 6 inch-pounds, tighten adjusting nut (42) - if more than 8 inch-pounds loosen nut. After proper adjustment is secured, install nut lock (42) and lock nut (37), tighten lock nut (37) and check adjustment again to ascertain that tightening lock nut did not change bearing adjustment. Then bend nut lock (36) lip against adjusting nut (43) on one side, and against lock nut (37) on the other side.

5. Carefully insert flange (38) into cover (41) and oil seal (40) assembly; then position cover gasket (54) on top of pinion cage (45). Insert splined end of drive pinion (49) into flange (38) and install nut (39) onto drive pinion (49).

6. Secure flange (38) in vise equipped with padded jaws, tighten nut (39) firmly; then align slots in nut (39) with cotter pin hole and install new cotter pin.

7. Install shim pack (32) which was removed at disassembly, over ends of studs (35). Insert drive pinion and cage assembly into differential carrier (30). Ascertain that marks previously made during disassembly on carrier (30) and cage (45) are in alignment. Align gasket (44) with stud holes in pinion cage (45) and cover (41); then

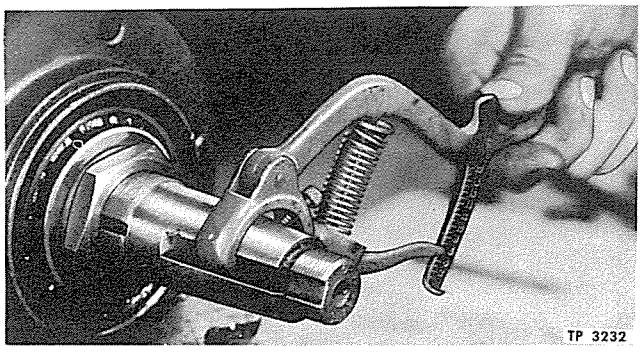


Figure 6—Typical Pinion Bearing Adjustment Test (Tool No. ABV-129)

push pinion cage (45) into place in carrier (30). Install nuts (34) and new lock washers (33) on studs (35). Then tighten nuts alternately and firmly.

DIFFERENTIAL CASE REASSEMBLY (Fig. 1)

1. Before assembling differential case, ascertain that differential case run-out has been checked as previously described in this section under "Inspection Operations."

2. Dip side gears (20), pinion gears (55), thrust washers (21 and 24) and spider (54) in differential lubricant; then permit excess lubricant to drain off parts. Install pinions (55) and thrust washers (24) on spider (54). Install washers (21) on hubs of gears (20). Place one gear (20) and washer (21) in left-hand section of case (10), position spider assembly on top of gear (20), then install other gear (20) and washer (21) on top of spider assembly.

3. Place right-hand section of case (10) in position on top of left section of case. Alignment marks (fig. 3) on sections of case must register correctly to be certain that case is assembled in original relative position. Insert bolts (7) into left-hand section of case (10) and through right-hand section; then install nuts (11) on bolts (7) and tighten nuts firmly. While nuts are being tightened, align slots in nuts (11) with holes in bolts (7) so that lock wire (15) can be installed to lock nuts in place after nuts (11) are tightened. Insert lock wire (15) through bolts, draw wire taut and secure ends of wire together.

4. Assemble drive gear (8) onto differential case (10), install bolts (29) which are used to attach gear (8) to case (10), then tighten bolts (29) securely and insert lock wire through heads of bolts (29) in such a manner so that lock wire will tighten if bolts loosen.

5. Install bearings (3) on case hubs (10) with a suitable piece of tubing which will bear on inner race of bearing (23). Make certain that bearings seat solidly on hubs of case.

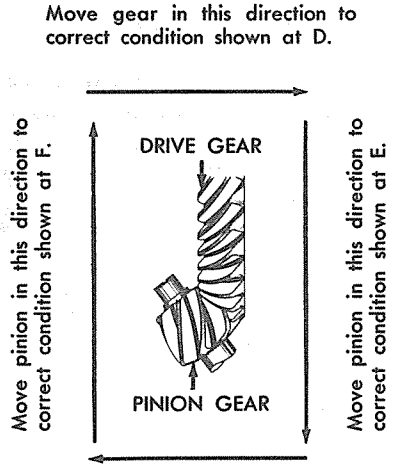
REAR AXLE (EARLY TYPE)

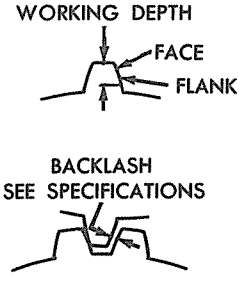
INSTRUCTIONS

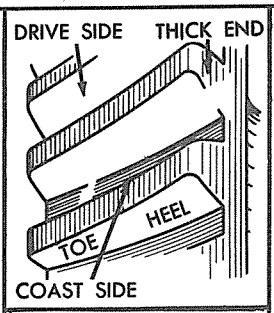
1—Install pinion with pinion bearings adjusted for proper end-play. Install differential assembly so that with bearings properly adjusted there will be sufficient backlash to permit final adjustment of pinion position to bring heels of teeth flush.

2—Paint three or four teeth of drive gear with red lead or Prussian blue and rotate pinion until bevel gear makes complete revolution.

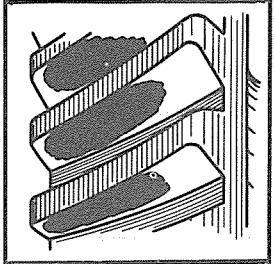
3—Vary position of pinion and drive gear as per chart until proper tooth contact is obtained. Be sure that sufficient backlash has been allowed so that drive gear can be completely revolved without any highspots being felt.



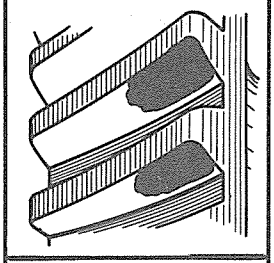




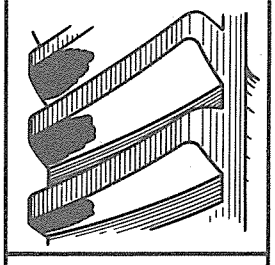
A—Check adjustments on drive side of drive gear tooth. Coast side will then automatically show a desirable tooth contact when adjusted correctly.



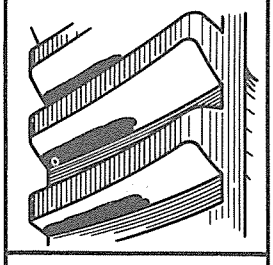
B—Shows correct tooth contact.



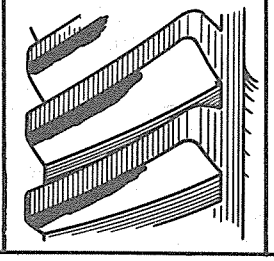
C—Shows short contact at heel. To correct, move drive gear toward pinion. Then move pinion away from drive gear to again secure correct blacklash.



D—Shows short contact at toe. To correct, move drive gear away from pinion. Then move pinion toward drive gear to again secure correct backlash.



E—Shows heavy contact on flank or lower portion of tooth. To correct, move pinion away from drive gear until contact comes to full working depth of gear tooth without breaking contact at flank. Then move drive gear toward pinion to secure correct backlash.



F—Shows heavy contact on face or upper portion of tooth. To correct, move pinion toward drive gear until contact covers flank of tooth without breaking contact at face. Then move drive gear away from pinion to secure correct backlash.

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Figure 7—Gear Tooth Contact Chart

DIFFERENTIAL & DRIVE GEAR INSTALLATION
(Key Numbers in Text Refer to Fig. 1)

1. Install bearing cups (4) over differential bearings (3), make certain that dowel pins are tight in bearing caps (5). Position differential case in carrier and install bearing caps (5). Turn nuts (14) on bearing cap studs (6) up tight and then back off sufficiently to allow adjusting rings (2) to turn.

2. Screw adjusting rings (2) into place in carrier (30) and tighten rings to seat bearings. Then back rings (2) off until differential turns freely but with no perceptible end play.

3. Adjust relative position of pinion gear (49) and bevel drive gear (10) so back ends of gear teeth are flush and back lash is within limits given in "Specifications" at end of this section. Position of bevel drive gear is adjusted by turning adjusting rings (2) in carrier (30) to relocate bearings (3). Left-hand adjusting ring must be tightened same amount as right-hand ring is loosened, or vice versa, to maintain correct adjustment of side bearings. Pinion gear is moved in or out by removing or adding shims (32) between carrier (30) and pinion cage (45). Refer to "Specifications" at end of this section for thickness of shims available. When cage (45) is finally assembled be sure oil holes are in line.

4. Paint bevel drive gear (10) teeth with a mixture of red lead and light oil. Turn bevel drive gear one complete revolution in direction of driving rotation. Examine tooth contact impressions and refer to "Gear Tooth Contact Chart," figure 7. Chart explains in detail method to follow to obtain correct tooth contact.

5. After completing adjustment of tooth contact and backlash, tighten side bearing cap stud nuts (16) fully and install adjusting ring locks (19) and bolts (18).

Backlash

Bevel gears are cut to have a definite amount of backlash which varies according to the pitch and operating conditions. This backlash is necessary for the safe and proper running of the gears. If gears are set too tightly they will be noisy, wear excessively, and possibly score the tooth surfaces. Use a dial indicator (fig. 8) to adjust bevel gear and pinion gear backlash. Refer to "Specifications" at end of this section for limits.

DIFFERENTIAL CARRIER INSTALLATION
(Key Numbers in Text Refer to Fig. 1)

1. Be sure lock wire is properly installed in all bolts in differential as required. Install differential carrier assembly including differential, pinion shaft and pinion cage in axle housing using new gasket (25) between carrier (30) and housing (1). Bushings (16) for bearing cap support studs (6) must be inserted in housing.

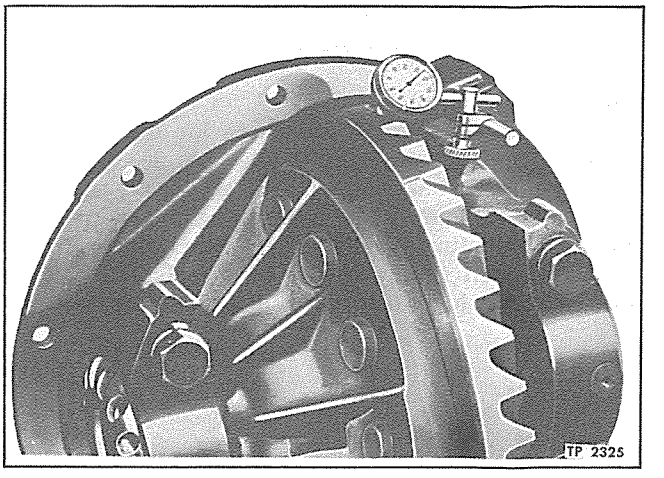


Figure 8—Typical Method of Checking Backlash

2. Insert locating bushing (16) in housing (1) over ends of bearing cap support studs (16). Then place new gasket (12) washer (13) and nuts (14), on in order. Tighten nuts (14) finger tight.

3. Screw nuts (27) on differential carrier studs (28) use lock washers (26) and tighten nuts (27) completely.

4. Tighten nuts (14) on support studs (16) completely after nuts (17) on carrier studs are tightened. Install breather nipple and cap on axle housing.

COMPLETING ASSEMBLY

1. Before installing axle shafts, (42) and (47) be sure that hubs have been removed, cleaned, inspected, bearings lubricated, replaced and adjusted as later directed in Hubs and Bearings (Sec. 19A, of this manual).

2. Install axle shaft (fig. 9) as previously directed under "Axle Shaft Installation" in this section.

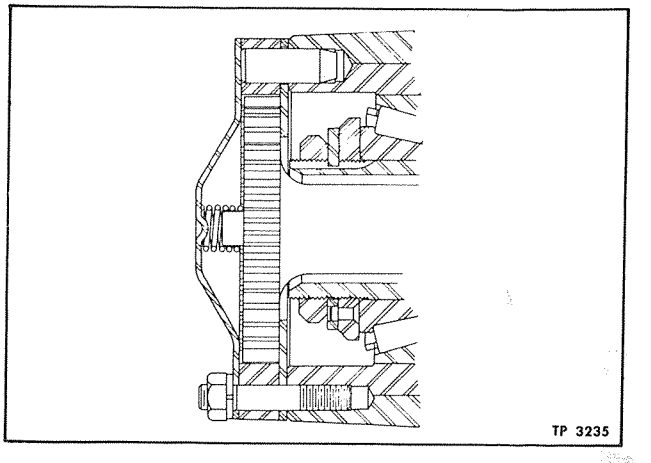


Figure 9—Axle Shaft Flange Installation at Rear Hub

REAR AXLE (EARLY TYPE)

3. Install axle assembly as previously directed under "Axle Assembly Installation" in this section.

LUBRICATION

Lubricants generally available for differentials thicken considerably after use due to oxidation and chemical reactions resulting from normal service conditions. This thickening seriously impairs lubricating qualities of lubricant and, if neglected, will finally result in semi-solids which will adhere to sides of housing and afford no lubrication whatever. It is essential, that, in addition to checking level of lubricant, its condition should be also considered. If there is any evidence of thickening differential should be drained and thoroughly cleaned.

Checking level and condition of lubricant frequently, together with periodic draining and refilling, is the best way to prevent lubricant thickening. Proper interval for refilling, as well as correct lubricant, is given in Lubrication (Sec. 13, of this manual).

SPECIFICATIONS

Type	Full Floating, Spiral Bevel Angle Pinion
Drive	Hotchkiss
Housing	Banjo Type
Differential	
Number of Pinions	4
GEAR RATIOS	
Standard	3-5/9:1
Optional	3-2/11:1
Optional	4-1/8:1
Differential Bearing Adjustment	Adjusting Rings (See Text)
Differential Case Run-out	.002"
Side Gear Thrust Washer Thickness	.125" - .121"
Pinion Thrust Washer Thickness	0.058" - .062"
Clearance Between	
Pinion and Spider	.004" - 0.007"
Differential Side Gear Hub and Spider	.002" - .006"
Side Gear Hub and Case	.009" - .016"
Drive Pinion Cage Assembly	
Inner Bearings	Straight Roller
Outer Bearings	Tapered Roller
Adjustment	Adjusting Nut (See Text)
Drive Pinion Backlash Adjustment	Shims
Shim Sizes Available	
4 @	.005" - .010" - 0.020" - 0.030"
Pinion and Bevel Gear Adjustment	
Pinion and Bevel Gear Backlash	0.008" - .012"
Method of Adjustment	(See Text)
Axle Housing	
Distortion	1/16 Max.
Axle Shafts	
Drive Flange Run-out not to Exceed	.005"
Shaft Run-out at Center	1/16"
Number Splines	16
Backlash Between -	
Side Gear and Axle Shaft Splines	0.001" - 0.005"
Diameter - At Splined End	2.300" - 2.290"

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however, are not supplied by GMC Truck & Coach Division. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

Tool No.	Name	Vendor Code
ABV-129	Pinion Bearing Torque Tester	ABV
CS-1047	Bearing Puller	

Vendor Code	Vendor Name	Address
ABV	K. R. Wilson Company	Buffalo, New York
CS	Curtiss Smith Mfg. Company	Pottstown, Pennsylvania

Rear Axle — Late Type

Contents of This Section

Related Subjects in Other Sections

Rear axle is full floating type. One-piece axle housing has cover welded to housing and housing bowl is offset toward right of vehicle. Drive pinion assembly is mounted at an angle as later illustrated in figure 1. Drive is transmitted from transmission angle drive unit through propeller shaft, spiral bevel gears, axle housing, and springs to vehicle underframe. Differential and pinion shaft assemblies both incorporate adjustments for bearings and gear tooth contact.

CONSTRUCTION

DIFFERENTIAL CARRIER

Differential assembly, pinion shaft and cage assembly, are mounted in differential carrier. After axle shafts have been removed, and propeller shaft has been disconnected, differential carrier can be removed for inspection and adjustment without removing axle housing from vehicle.

DIFFERENTIAL ASSEMBLY

Conventional four-pinion type differential is carried in two-piece case mounted on tapered roller bearings. Bevel drive gear is bolted to flanged half of differential case. Drive gear and pinion are furnished in matched lapped sets, and should always be installed as such to assure satisfactory operation.

Thrust washers are used between differential side gears and case and differential pinions and case. Each pinion contains an aluminum bronze bushing. When bushings become worn, pinions must be replaced. Differential case halves are held together with special bolts and slotted nuts, locked in place with lock wire.

DIFFERENTIAL SIDE BEARINGS

Differential case is supported in tapered roller bearings which take thrust as well as radial loads. Bearings are mounted in machined supports in differential carrier with thrust loads taken against adjusting rings threaded into carrier supports and bearing caps. Adjusting rings bear against bearing cups and are locked in position by adjusting ring locks bolted to each bearing cap.

Method of adjusting differential side bearings is explained under "Differential Case and Drive Gear Installation" later in this section.

DRIVE PINION & CAGE ASSEMBLY

Bevel drive pinion is installed at an angle in differential carrier. Pinion is straddle mounted in two opposed tapered roller bearings at outer end, and one straight roller bearing at inner end.

Tapered roller bearing cups are installed in pinion cage (fig. 1), separated by a machined shoulder in brake spider assembly.

Pinion bearings are adjusted on shaft by selecting correct size spacer as later described in this section.

Straight roller bearing at inner end of drive pinion, is secured in place with retainer and a bolt.

Shims of various thicknesses are used between bearing cage and differential carrier to adjust drive pinion tooth contact and gear backlash.

Pinion shaft and cage assembly cannot be removed from carrier until differential case assembly including drive gear has been removed from carrier.

REAR AXLE—LATE TYPE

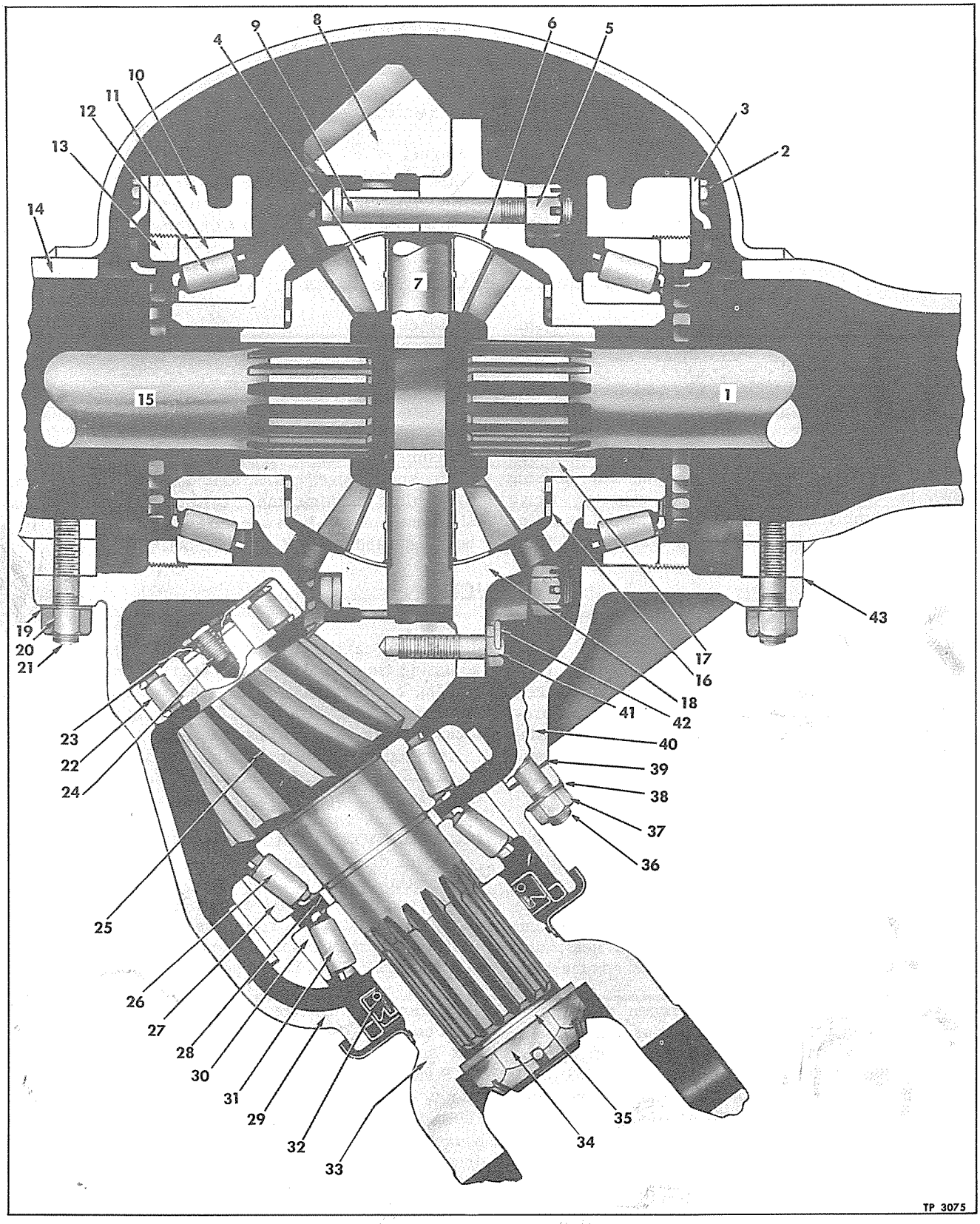


Figure 1—Sectional View of Rear Axle

REAR AXLE—LATE TYPE

1 Axle Shaft (Right-Hand)
2 Adjusting Ring Lock Bolt
3 Adjusting Ring Lock
4 Differential Pinion
5 Differential Case Bolt Nut
6 Differential Pinion Thrust Washer
7 Differential Spider
8 Drive Gear (Matched Assembly)
9 Differential Case Bolt
10 Differential Bearing Cap
11 Differential Side Bearing Cup
12 Differential Side Bearing Cone
13 Differential Bearing Adjusting Ring
14 Axle Housing Assembly
15 Axle Shaft (Left Hand)
16 Differential Side Gear Thrust Washer
17 Differential Side Gear
18 Differential Case Assembly
19 Lock Washer
20 Differential Carrier Stud Nut
21 Differential Carrier Stud
22 Drive Pinion Inner Bearing (Straight Roller)
23 Bearing Retainer
24 Pinion Bearing Retainer Bolt
25 Drive Pinion (Matched Assembly)
26 Drive Pinion Inner Bearing Cone (Tapered Roller)
27 Inner Bearing Cup
28 Drive Pinion Bearing Spacer (Shim)
29 Pinion Cage and Bearing Cup Assembly
30 Outer Bearing Cup
31 Drive Pinion Outer Bearing Cone (Tapered Roller)
32 Oil Seal Assembly
33 Propeller Shaft Flange
34 Drive Pinion Nut
35 Drive Pinion Nut Washer
36 Pinion Cage Stud
37 Pinion Cage Stud Nut
38 Lock Washer
39 Pinion Cage Shims (A.R.)
40 Differential Carrier Assembly
41 Drive Gear Bolt
42 Drive Gear Bolt Lock Wire
43 Differential Carrier Gasket

TP 3075 B

Captions For Figure 1

AXLE SHAFT AND HOUSING

Axle shafts are full floating type. Drive flange at outer ends have external teeth which mesh with similar internal teeth on hub drive plate. Drive plate is doweled to hub with dowel pins and held n place together with plate cover with ten hub studs and nuts as later illustrated in figure 8.

Axle housing is one-piece design with differential located off center. Housing is equipped with removable outer end tubes which are threaded to accommodate wheel bearing adjusting nuts.

AXLE MAINTENANCE ON VEHICLE

At regular intervals, the rear axle should be inspected as follows:

1. Axle Shaft Cover Stud Nuts. Examine stud nuts and studs which secure drive plate covers on hubs for looseness and tighten nuts firmly if necessary. Use new lock washers under nuts if required.

2. Lubricant Leaks. Check pinion shaft oil seal and cover gasket, axle shaft plate and cover gaskets, and differential carrier gasket for leaks. Correct leaks by tightening bolts and stud nuts, or by replacing gaskets or oil seals.

3. U-Bolts. Check and tighten spring bolts. Examine axle for misalignment. This can be done by measuring from rear spring front bracket bolt to end of axle. A measurement taken between identical points at opposite end of axle should be the same as first measurement, if axle is properly aligned.

4. Axle Housing Check. If bent axle housing is suspected, check as directed under "Axle Repair" later in this section.

5. Lubricant. Check lubricant level at regular intervals. Add lubricant as required. Refer to Lubrication (Sec. 13 in this manual), for correct type of differential lubricant.

Housing should be kept filled to level of filler plug. Drain plug is at lowest point of housing.

AXLE SHAFT REPLACEMENT

AXLE SHAFT REMOVAL

1. Remove outer drive plate cover, cover spring and gasket. Insert 1/2"-13 cap screw in tapped hole in axle flange. Screw should be long enough to pull axle flange free from drive plate teeth. Withdraw axle shaft from housing.

2. If it is necessary to remove drive plate, do not remove axle shaft. Instead, use a suitable puller which will exert pressure on flange and may be attached to drive plate with three 1/2"-13 cap screws of sufficient length so drive plate teeth will clear flange teeth.

AXLE SHAFT INSTALLATION

1. Before axle shafts are installed, ascertain that hub bearings are in proper adjustment; then

insert drive plate dowel pins into place. Three gaskets are used at flange end of each axle shaft, namely between hub and drive plate, drive plate and drive ring, and between drive plate and plate cover.

2. Install over end of hub studs in sequence gasket, drive ring, gasket, drive plate and gasket; then dip splined end of axle in differential lubricant and insert shaft into hub. Align shaft splines with side gear splines, and flange teeth with drive plate teeth; then push shaft into place. Make certain the small spring between drive plate cover and shaft flange is located correctly on bosses of flange and cover.

3. Install nuts and new lock washers on studs; then tighten nuts alternately and firmly.

AXLE ASSEMBLY REPLACEMENT

AXLE ASSEMBLY REMOVAL

1. Remove drain plug and drain lubricant from axle housing. Loosen wheel stud nuts until nuts are finger tight.

2. Place jacks under axle housing, then raise vehicle. When rear of vehicle is supported with blocks placed in front of rear axle and jacks are removed, wheels should clear floor.

3. Remove jacks after blocks are securely in place under vehicle. Remove rear wheel stud nuts, then remove wheels.

4. Disconnect air lines at brake chambers.

5. Disconnect propeller shaft slip joint dust seal cap. Refer to propeller Shaft (Sec. 18 of this manual), for complete information on propeller shaft removal.

6. Loosen spring bolt nuts until nuts are finger tight.

7. Place a suitable dolly jack under axle housing. Be sure axle is cradled securely and properly balanced on jack. Raise axle assembly sufficiently to take weight of axle off springs.

8. Remove spring bracket side plates at rear end of both rear springs. Refer to Spring Suspension (Sec. 15 of this manual). Lower axle permitting springs to pivot on front shackle pins.

9. Remove spring bolts to free axle from springs.

10. Remove axle assembly by pulling dolly jack, supporting axle, out from under rear end of vehicle. Rear springs need not be removed from vehicle.

AXLE ASSEMBLY INSTALLATION

1. Carefully check, inspect and replace, as necessary, parts in propeller shaft universal joints, rear spring mountings, wheels and rear hubs. Each of these items is covered in detail, in its respective section elsewhere in this manual.

2. With rear axle completely assembled and supported on dolly jack, roll assembly into place under vehicle. Assemble propeller shaft slip joint. Align axle as required to accomplish assembly. Arrow markings on propeller shaft must be in alignment to assure assembling of universal joints in proper plane and balance. Refer to Propeller Shafts (Sec. 18 of this manual).

3. Position axle housing on springs and align center bolt head in recess provided in housing for center bolt. Position bolt spacer on top of housing, then install bolts in spacer and housing. Place spring retainer plate over ends of bolts and install nuts on bolts, finger tight.

4. Raise axle housing and align rear ends of spring in position. Install spring brackets as directed in Spring Suspension (Sec. 15 of this manual).

5. Lower dolly jack, then tighten bolt nuts firmly.

6. Connect brake air lines at brake chambers, refer to Brakes (Sec. 4B of this manual).

7. Install rear wheels and tighten stud nuts. Refer to Wheels and Tires (Sec. 19B of this manual).

8. Raise dolly jack under axle housing sufficiently to remove blocks which support vehicle, then lower jack and remove from under vehicle.

9. Be sure that axle housing is filled to correct level with proper lubricant and filler plug installed. Refer to Lubrication (Sec. 13 of this manual).

REAR AXLE REPAIR

The following instructions provide procedures for removal, complete disassembly, cleaning, inspection, repair and assembly of rear axle.

Axle shafts and differential carrier assembly may be removed from axle housing for repair or replacement without removing entire axle assembly from the vehicle. For a complete inspection and rebuilding of the entire assembly, it is recommended that rear axle be removed from the vehicle.

AXLE HOUSING CHECK (Before Removal)

At regular intervals, or when it is suspected that rear axle is bent, a check should be made

by the following method. This check can be made before the axle assembly is removed from the vehicle, and in that manner determine the extent of repairs required. The check is made with conventional front end alignment camber and toe-in equipment.

1. Check hub bearing adjustment and adjust bearings if required. Refer to Hubs and Bearings (Sec. 19A of this manual). Check rear wheels for run-out or "wobble" in the following manner:

a. Place vehicle on smooth level floor; then raise rear axle with a jack and place supports under each side of axle housing.

b. Make certain that wheels are mounted solidly on hubs and that wheel nuts are tightened firmly. Position a spring type scriber or marker (same type used to mark center of tire treads when checking front end alignment), at right angle to rear outside wheel rim. Point of scribe should be placed 1/8" away from wheel rim.

c. Revolve wheel slowly, and at the same time, note if rim of wheel contacts point of scriber or, if gap between scriber point and rim increases or diminishes. If run-out exceeds 3/32 inch (new limits), wheel should be replaced with one that does not exceed new limits. Perform check on both rear wheels.

2. Lower wheels to floor. Place a conventional camber gauge on rim of wheel. Note reading, if reading exceeds 0 degree, plus or minus 1/4 degree, axle housing is bent on that side. Repeat check on opposite wheel and note reading on camber gauge. If reading exceeds 0 degree, plus or minus 1/4 degree, that side is also bent.

3. Place a conventional toe-in gauge between inner tires in front of rear axle under vehicle close to bottom side of springs. Note reading at each end of instrument; then carefully roll vehicle forward until instrument is close to bottom side of springs at rear of vehicle. Again note readings at ends of instrument, if second reading exceeds the first by more than 1/4 degree, the side (right or left) of the axle on which the variation exists, is bent forward or backward as denoted by the reading.

AXLE DISASSEMBLY

(Key Numbers in Text Refer to Fig. 1)

Before and during disassembly operations, a preliminary inspection and check of all adjustments should be made to determine repairs required. Proceed as follows:

1. Disconnect propeller shaft universal joint at drive pinion flange and remove axle assembly from vehicle as previously directed under "Axle Assembly Replacement" in this section.

2. Perform a visual check on the exterior of axle housing for leaks, damage, cracks, etc.,

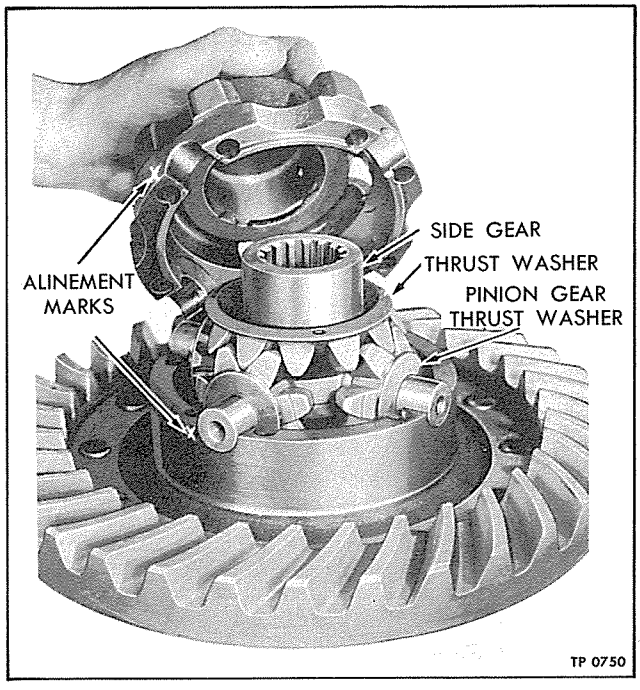


Figure 2—Typical Differential Case Showing Alignment Marks

which are usually detected before axle housing is cleaned. Note all evident conditions to assist in the repair of axle assembly. After inspection is completed, clean exterior of axle housing thoroughly with a suitable cleaning fluid and a stiff bristled brush, or use steam cleaning.

3. After differential carrier assembly is removed from housing, check drive pinion for end play and note if end play is evident. Check differential case assembly run-out and backlash before removal of differential and make note of same for later reference during repair.

4. At this point hubs should be removed, cleaned, inspected, lubricated, replaced and adjusted as outlined in Hubs and Bearings (Sec. 19A in this manual).

DIFFERENTIAL CARRIER REMOVAL (Fig. 1)

1. Remove axle shafts as previously instructed under "Axle Shaft Replacement" in this section.

2. Remove drain plug and drain lubricant from housing while loosening differential carrier stud nuts.

3. Remove stud nuts and lock washers from housing to carrier studs.

4. Be certain that differential carrier is supported solidly, then proceed to pull complete carrier assembly out of housing.

DIFFERENTIAL REMOVAL FROM CARRIER

1. Remove lock wire from bolts (2) which lock adjusting rings (13).

2. Remove nuts from differential side bearing

REAR AXLE—LATE TYPE

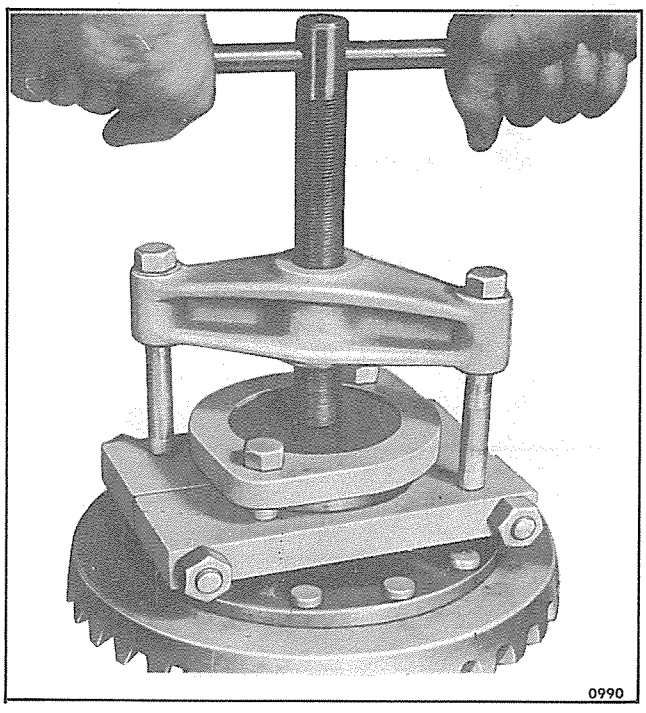


Figure 3—Removal of Differential Side Bearings (Tool No. CS-1047)

cap studs. Make certain that bearing caps and carrier are marked before removal; then remove side bearing caps (10) and cups (11), and lift out differential assembly including drive gear (8), side bearings (12). Remove side bearing adjusting rings (13).

DIFFERENTIAL CASE DISASSEMBLY

1. Mark both halves of case so halves may be reassembled in original positions (fig. 2).

2. Remove side bearings (33) from each half of case, using special bearing puller CS-1047 (fig. 3).

3. Remove lock wire and nuts (5) from the bolts (9) which hold the two halves of differential case (18) together; then separate case (18).

4. Remove side gears (17), thrust washers (16) and (6), spider (7) and pinions (4).

5. If either drive gear (8) or pinion (25) are worn or damaged, both must be replaced as a matched set. Never replace pinion or ring gear alone.

PINION CAGE REMOVAL AND DISASSEMBLY (Fig. 1).

1. Mark pinion cage (29) and differential carrier (40) so parts can be reassembled in the same relative position. Remove nuts (37) and lock washers (38) which secure cage (29) on carrier (40).

2. Install and tighten puller screws alternately to pull cage (29) out of carrier; then note quantity and remove shim (39) pack from carrier. Tie shims (39) together so same shim (39) pack may be used at reassembly.

3. Remove bolt (24) and retainer (25) which secure inner bearing (22) on drive pinion (25); then remove inner bearing (22) from drive pinion (25) with a suitable puller.

4. Clamp flange (33) in vise equipped with padded jaws. Remove cotter pin and nut (34) from drive pinion (25).

5. Place cage and drive pinion assembly in an arbor press and press drive pinion out of flange (33) and pinion cage. Outer bearing (31) will remain in pinion cage (29).

6. Remove shim (28) from drive pinion (25). Use special bearing puller (CS-1047) and remove inner bearing (26) from drive pinion (25); then remove oil seal (32). Inspect bearing cups (27) and (30). If bearing cups must be removed from cage (29), use brass drift and carefully drive cups out of pinion cage.

CLEANING, INSPECTION, AND REPAIR

CLEANING BEARINGS

1. Immerse differential and drive pinion bearings in gasoline, kerosene, or other suitable cleaning fluid. Leave bearings in fluid long enough so fluid will dissolve and loosen old lubricant. After bearings have been soaked in fluid a sufficient length of time, bearings should be alternately slushed up and down and spun slowly below the surface of liquid to remove old lubricant.

2. Remove bearing from fluid, then strike large side of bearing flat against wooden block to jar loose heavy and larger particles of lubricant. Repeat until bearings are thoroughly clean.

3. Rinse bearings out in clean fluid, then blow bearings dry with compressed air. CAUTION: Do not spin bearings while blowing them dry with compressed air. After bearings have been inspected as later described in this section of the manual, and bearings are going to be used, dip bearings in differential lubricant recommended in Lubrication (Sec. 13 of this manual), and wrap in clean cloth or paper until needed.

CLEANING PARTS

1. Immerse all parts in suitable cleaning fluid and clean parts thoroughly. Use a stiff bristle brush as required to assure removal of any accumulation of old lubricant, etc., which may be evident. Remove particles of gaskets which may adhere to mating faces of axle housing, differential carrier, cover oil seal retainer, hubs and axle shaft flanges. Clean lubricant channels in pinion cage and differential carrier as required.

Clean housing breather. Make certain that axle housing is thoroughly cleaned.

INSPECTION

Whenever available, the Magna Flux Method should be used on all steel parts, except ball and roller bearing. This method is especially suited for inspection of ground or highly finished surfaces for wear and cracks which otherwise would not be visible to the naked eye.

INSPECTION OPERATIONS

1. Bearings. Rotate each bearing slowly, and at the same time examine bearing for roughness, damage, defects, or wear. Note condition of bearing cage and replace bearing if cage is damaged or if any of the conditions previously noted are evident.

2. Gears. Examine drive gear and drive pinion, differential side gears closely for damaged teeth, worn spots in surface hardening and distortion. Examine bushings in differential pinions for grooves, or excessive wear and check fit of gears on spider. Refer to "Specifications" later in this section for limits. Inspect drive gear rivets for looseness, replace loose rivets. Check radial clearances between differential side gears and differential pinions on spider. Refer to "Specifications" at end of this section for limits.

3. Differential Case. Inspect differential case assembly for cracks, distortion or damage, if case is in good condition, thoroughly clean case and cover; then assemble case with bolts and mount in lathe centers or "V" block stand. If lathe is not available, install differential side bearings and mount case in differential carrier as directed under "Differential and Drive Gear Installation" later in this section. Install dial indicator and check differential case run-out. Refer to "Specifications" at end of this section, for run-out limits. Whenever run-out exceeds limits differential case run-out may be corrected as later described under "Repair" in this section.

4. Axle Shafts. Examine splined end of axle shaft for twisted or cracked splines, twisted shaft, and damaged teeth on flange. If any of above conditions are evident, install new axle shafts.

5. Axle Shaft and Flange Run-out. Install axle shaft assembly in lathe centers or "V" blocks and check shaft run-out with dial indicator, if run-out exceeds limits listed under "Specifications at end of this section, discard axle shaft. Position dial indicator so that indicator shaft end contacts inner surface of flange near outer edge of flange and check flange run-out. Whenever run-out exceeds limits listed under "Specifications" at end of this section, discard axle shaft.

AXLE HOUSING INSPECTION

1. Thoroughly clean inside of housing as well as outer ends. Temporarily install wheel hubs. Refer to Hubs and Bearings (Sec. 19A of this manual), and Lubrication (Sec. 13 of this manual).

2. Adjust wheel bearing nuts so that hubs will just turn; however, do not lock adjustment at this time. Install axle shafts, dowels and nuts; then tighten nuts firmly. NOTE: Axle shafts should be

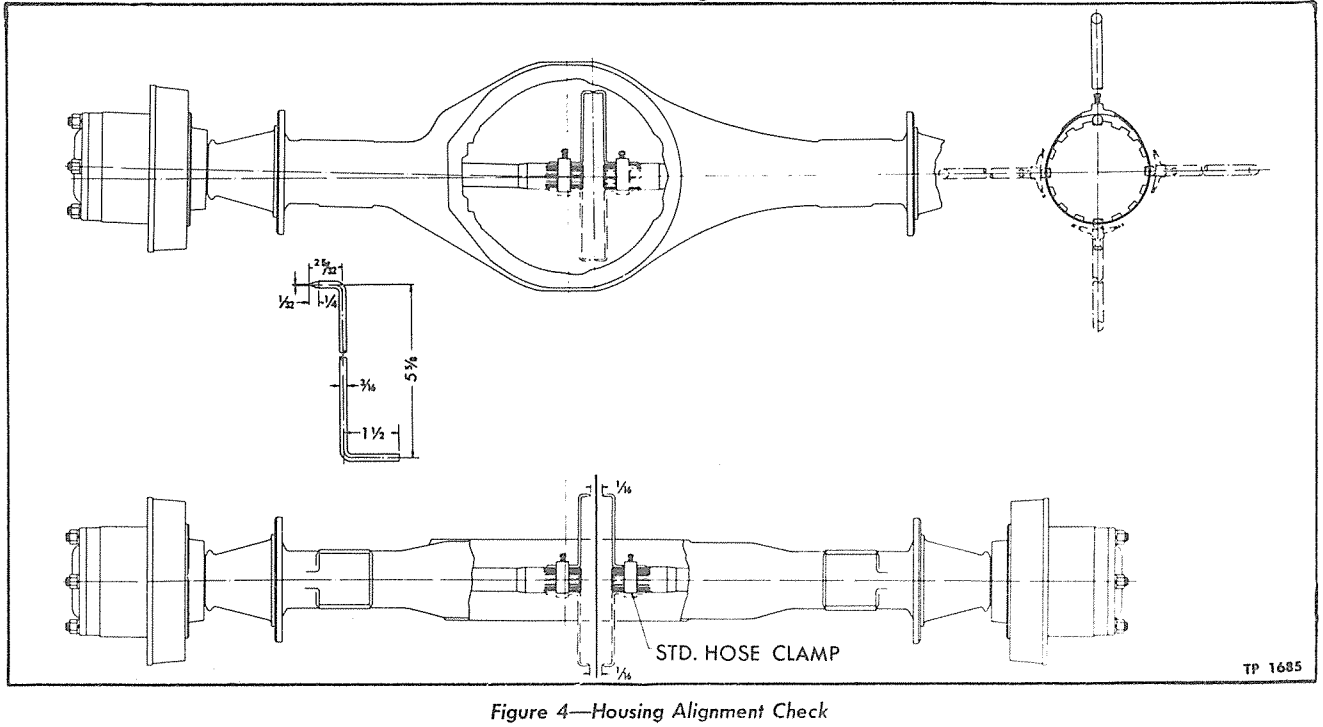


Figure 4—Housing Alignment Check

REAR AXLE—LATE TYPE

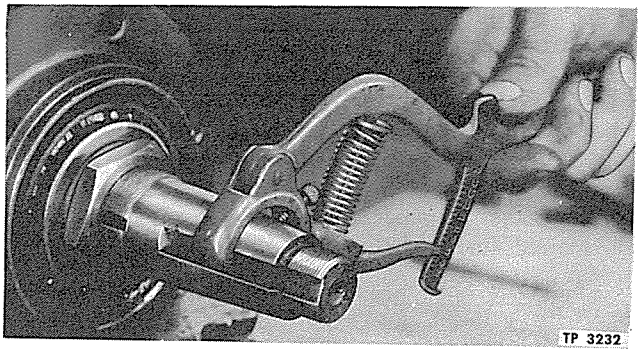


Figure 5—Typical Pinion Bearing Adjustment Test (Tool No. ABV-129)

inspected as previously described under "Inspection Operations" in this section, before installation.

3. Indicators, as shown in figure 4, may be made locally from welding or drill rod (3/16" diameter) to dimensions shown. Make certain that burrs on axle shaft splines have been removed. Install indicators in place as shown in figure 4. Radiator hose clamps of suitable diameter may be used to secure indicators in position.

4. Each indicator must be positioned at right angle to its respective axle shaft after it is secured in place. Both indicators must be in alignment with each other. There should be a slight gap between the points as shown in figure 4. Insert a feeler gauge or measure gap between the indicator points, and make note of this dimension.

5. Place both indicators in alignment, then rotate both shafts simultaneously. Make a check of the gap dimensions between the indicators at four points 90 degrees apart, as shown in figure 4. If the gap at each point exceeds original predetermined gap by more than 1/16," axle housing is bent at various points and should be straightened or replaced.

OIL SEAL INSPECTION

Replacement of spring loaded oil seal whenever unit is disassembled is more economical than premature overhaul to replace these parts at a future time. Further, loss of lubricant through a worn seal may result in failure of other parts, such as gears and bearings.

Handle seals carefully, particularly when seals are being installed. Cutting, scratching or curling under of lip of seal seriously impairs efficiency of seal. Use of Permatex or equivalent around outer diameter of seal is recommended to insure against leakage at that point.

REPAIR

Differential Case. Excessive run-out on differential case may be corrected by machining flange on gear side of case. Remove sufficient metal from gear face of flange on differential case to correct excessive run-out. The metal must be cut on a true plane removing just enough metal to bring run-out within limits listed under "Specifications" at end of this section. After differential case has been machined, remove burrs and clean case assembly thoroughly.

Propeller Shaft Flange. Whenever inspection indicates that exterior surface of flange which contacts oil seal is corroded or pitted, the condition may be corrected by cleaning and polishing surface with a suitable abrasive cloth. If cleaning and polishing surface of flange does not clear up the condition, discard flange and install new parts.

REASSEMBLY

(Key Numbers in Text Refer to Fig. 1)

Before the axle is reassembled, make certain that all parts have been thoroughly cleaned, and that a thin coating of differential lubricant specified in Lubrication (Sec. 13 of this manual), is applied on all thrust and bearing surfaces to prevent scoring of parts when vehicle is first placed in service.

New lock washers, gaskets, and oil seals are recommended throughout during reassembly of axle. Make certain that all threads on bolts, screws, etc., are in good condition before they are installed.

Adjustments must be carefully made to insure efficient and continuous operation.

DRIVE PINION & CAGE REASSEMBLY (Figs. 1 and 5)

1. Press bearing cups (27) and (30), into pinion cage (29) if cups have been removed.

2. Press bearing assembly (26) on drive pinion (25) with widest part of bearing cone (26) toward gear teeth. Make certain that bearing (26) seats solidly against gear teeth.

3. Install bearing spacer (28) over splined end of drive pinion (25). Refer to "Specifications" at end of this section, for sizes available. Insert splined end of drive pinion (25) into pinion cage (29); then install outer bearing (31) in cage (29) on top of spacer (28).

4. Secure a short piece or pipe of tubing which will fit over splined end of drive pinion (25), and of sufficient diameter so that it will bear on inner race of outer pinion bearing (31). Pipe should be short enough so that after installation onto drive pinion is made, washer (35) can be placed on top of pipe and drive pinion nut (34) screwed onto drive pinion (25).

5. Tighten nut (34), 700 to 900 foot pounds torque with a torque wrench which will obtain a bearing adjustment of .000" to .002" tight when

correct spacer is used. Bearing adjustment may be checked with torque wrench (fig. 5) and reading obtained, should be 6 to 8 inch pounds torque. If torque wrench reading exceeds limits, install thicker spacer (28). When reading is below limits, install thinner spacer (28).

6. Install bearing (22) on inner end of drive pinion (25) and lock in place with new retainer (23) and bolt (24).

7. After bearing adjustment is completed; remove nut, washer and pipe or tubing from drive pinion (25); then install oil seal (32) in pinion cage (29).

8. Make certain that splines on pinion (25) and in flange (33) are cleaned; then install flange (33) and dust slinger on drive pinion (25). Attach flange with nut (34). Tighten nut (34) with torque wrench 700 to 900 foot pounds torque. Align cotter pin hole in drive pinion (25) with slots in nut (34) and install new cotter pin full size of hole.

9. Dip end of pinion with roller bearing (22) in differential lubricant. Install cage assembly (29) in differential carrier (40) using same number and thickness of shims (39) between cage flange and carrier as were removed. Be certain oil holes in cage assembly (29) and shims (39), index with those in carrier (40) to assure proper lubrication. Install nuts (37), and new lock washers (38) on studs (36). Tighten nuts firmly.

DIFFERENTIAL CASE REASSEMBLY (Fig. 1)

1. Before assembling differential case, ascertain that differential case run-out has been checked as previously described in this section under "Inspection Operations."

2. Dip side gears (17), pinion gears (4), thrust washers (6 and 16) and spider (7) in differential lubricant; then permit excess lubricant to drain off parts. Install pinions (4) and thrust washers (6) on spider (7). Install washers (16) on hubs of gears (17). Place one gear (17) and washer (16) in left-hand section of case (18), position spider assembly on top of gear (17), then install other gear (17) and washer (16) on top of spider assembly.

3. Place right-hand section of case (18) in position on top of left section of case. Alignment marks (fig. 3) on sections of case must register correctly to be certain that case is assembled in original relative position. Insert bolts (9) into left-hand section of case (18) and through right-hand section; then install nuts (5) on bolts (9) and tighten nuts firmly. While nuts are being tightened, align slots in nuts (5) with holes in bolts (9) so that lock wire can be installed to lock nuts in place after nuts (5) are tightened. Insert lock wire through bolts, draw wire taut and secure ends of wire together.

4. Assemble drive gear (8) onto differential case (18), install bolts (41) which are used to attach gear (8) to case (18), then tighten bolts (41) securely and insert lock wire (42) through heads of bolts (41) in such a manner so that lock wire will tighten if bolts loosen.

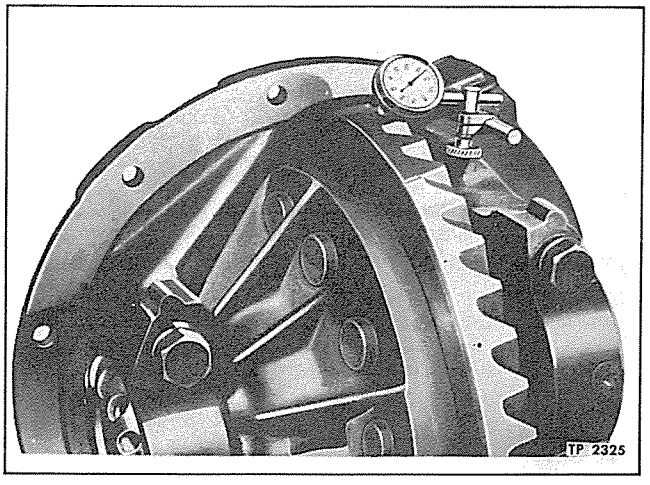


Figure 6—Typical Method of Checking Backlash

5. Install bearings (12) on case hubs (18) with a suitable piece of tubing which will bear on inner race of bearing (12). Make certain that bearings seat solidly on hubs of case.

DIFFERENTIAL CASE DRIVE GEAR INSTALLATION (Fig. 1)

1. Install bearing cups (11) over differential bearings (12). Make certain that dowel pins are tight in bearing caps (10). Position differential case in carrier and install bearing caps (10). Turn nuts on bearing cap studs up tight and then back off sufficiently to allow adjusting rings (13) to turn.

2. Screw adjusting rings (13) into place in carrier (40) and tighten rings to seat bearings. Then back rings (13) off until differential turns freely but with no perceptible end play.

3. Adjust relative position of pinion gear (25) and drive gear (8) so back ends of gear teeth are flush and back lash is within limits given in "Specifications" at end of this section. Position of drive gear is adjusted by turning adjusting rings (13) in carrier (40) to relocate bearings (12). Left-hand adjusting ring must be tightened same amount as right-hand ring is loosened, or vice versa, to maintain correct adjustment of side bearings. Pinion gear is moved in or out by removing or adding shims (39) between carrier (40) and pinion cage (29). Refer to "Specifications" at end of this section for thickness of shims available. When cage (29) is finally assembled be sure oil holes are in line.

4. Paint drive gear (8) teeth with a mixture of red lead and light oil. Turn drive gear one

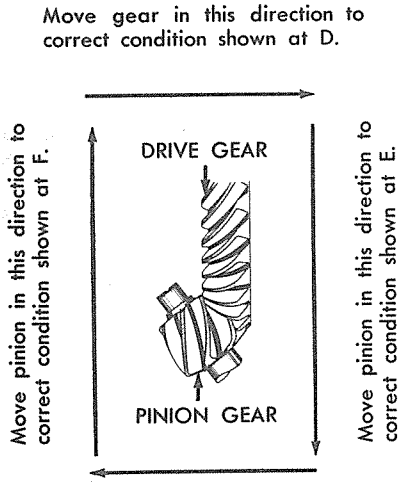
REAR AXLE—LATE TYPE

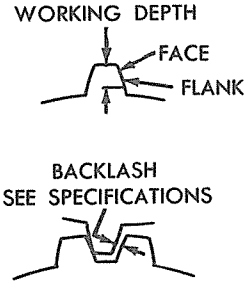
INSTRUCTIONS

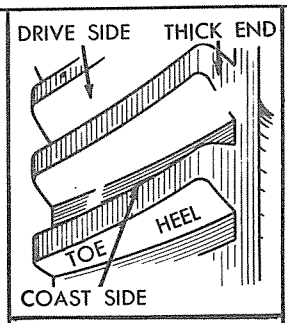
1—Install pinion with pinion bearings adjusted for proper end-play. Install differential assembly so that with bearings properly adjusted there will be sufficient backlash to permit final adjustment of pinion position to bring heels of teeth flush.

2—Paint three or four teeth of drive gear with red lead or Prussian blue and rotate pinion until bevel gear makes complete revolution.

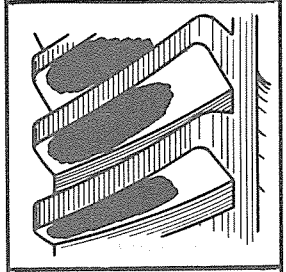
3—Vary position of pinion and drive gear as per chart until proper tooth contact is obtained. Be sure that sufficient backlash has been allowed so that drive gear can be completely revolved without any highspots being felt.



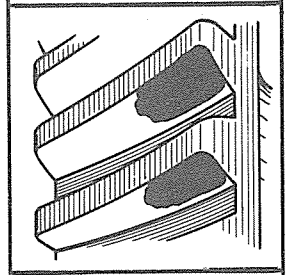




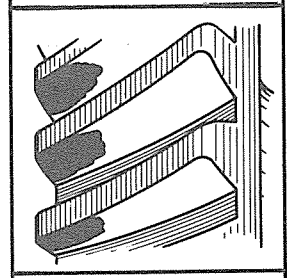
A—Check adjustments on drive side of drive gear tooth. Coast side will then automatically show a desirable tooth contact when adjusted correctly.



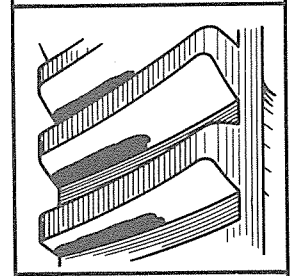
B—Shows correct tooth contact.



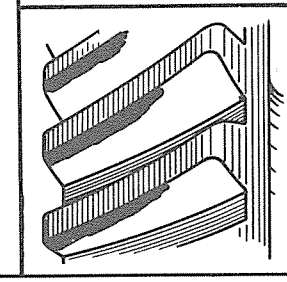
C—Shows short contact at heel. To correct, move drive gear toward pinion. Then move pinion away from drive gear to again secure correct blacklash.



D—Shows short contact at toe. To correct, move drive gear away from pinion. Then move pinion toward drive gear to again secure correct backlash.



E—Shows heavy contact on flank or lower portion of tooth. To correct, move pinion away from drive gear until contact comes to full working depth of gear tooth without breaking contact at flank. Then move drive gear toward pinion to secure correct backlash.



F—Shows heavy contact on face or upper portion of tooth. To correct, move pinion toward drive gear until contact covers flank of tooth without breaking contact at face. Then move drive gear away from pinion to secure correct backlash.

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Figure 7—Gear Tooth Contact Chart

complete revolution in direction of driving rotation. Examine tooth contact impressions and refer to "Gear Tooth Contact Chart," figure 7. Chart explains in detail method to follow to obtain correct tooth contact.

5. After completing adjustment of tooth contact and backlash, (fig. 6) tighten side bearing cap stud nuts fully and install adjusting ring locks (3) and bolts (2).

Backlash

Bevel gears are cut to have a definite amount of backlash which varies according to the pitch and operating conditions. This backlash is necessary for the safe and proper running of the gears. If gears are set too tightly they will be noisy, wear excessively, and possibly score the tooth surfaces. Use a dial indicator (fig. 6) to adjust bevel drive gear and pinion gear backlash. Refer to "Specifications" at end of this section for limits.

DIFFERENTIAL CARRIER INSTALLATION

1. Be certain flanges of carrier (40) and housing (14) are clean and smooth.

2. Place a new gasket (43) on housing.

3. Install carrier in housing and install new lock washers (19) and nuts (20), tighten nuts (20) up evenly to prevent distortion of flange.

4. Connect propeller shaft at pinion flange. Refer to Propeller Shafts (Sec. 18 of this manual).

5. Make certain that drain plug is installed and tightened firmly. Fill axle housing to proper level using correct lubricant as specified in Lubrication (Sec. 13 of this manual). Be sure to replace and tighten filler plug.

COMPLETING ASSEMBLY

1. Before installing axle shafts, (1) and (15), be sure that hubs have been removed, cleaned, inspected, bearings lubricated, replaced and adjusted as later directed in Hubs and Bearings (Sec. 19A of this manual).

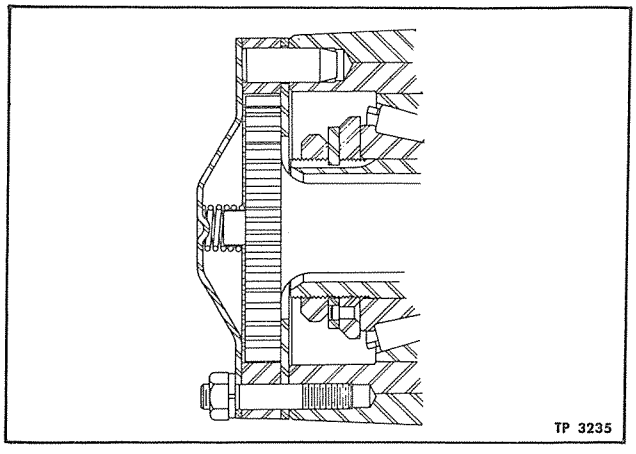

Figure 8—Axle Shaft Flange Installation

2. Install axle shaft (fig. 8) as previously directed under "Axle Shaft Installation" in this section.

3. Install axle assembly as previously directed under "Axle Assembly Installation" in this section.

LUBRICATION

Lubricants generally available for differentials thicken considerably after use due to oxidation and chemical reactions resulting from normal service conditions. This thickening seriously impairs lubricating qualities of lubricant and, if neglected, will finally result in semi-solids which will adhere to sides of housing and afford no lubrication whatever. It is essential, that, in addition to checking level of lubricant, its condition should be also considered. If there is any evidence of thickening differential should be drained and thorough cleaned.

Checking level and condition of lubricant frequently, together with periodic draining and refilling, is the best way to prevent lubricant thickening. Proper interval for refilling, as well as correct lubricant, is given in Lubrication (Sec. 13 of this manual).

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however are not supplied by GMC Truck & Coach Division. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

Tool No.	Name	Vendor Code
ABV-129	Pinion Bearing Torque Tester	ABV
CS-1047	Bearing Puller	CS

Vendor Code	Name and Address
ABV	K. R. Wilson Co. - Buffalo, N. Y.
CS	Curtiss Smith Mfg. Co. - Pottstown, Pa.

REAR AXLE—LATE TYPE

SPECIFICATIONS

(New Limits)

Type	Late Type
Type	Full Floating Spiral Bevel Angle Pinion
Drive	Hotchkiss
Housing	Banjo Type
Differential	
Number of Pinions	4
GEAR RATIOS	
Standard	3-5/9:1
Optional	3-2/11:1
Optional	4-1/8:1
Differential Bearing Adjustment	Adjusting Rings (See Text)
Differential Case Run-out	.002 Max.
Side Gear Thrust Washer Thickness	0.121" - .125"
Pinion Thrust Washer Thickness	0.058" - .062"
Clearance Between	
Pinion and Spider	0.003" - .007"
Side Gear Hub and Case	0.008" - .012"
Drive Pinion Cage Assembly	
Inner Bearing	Straight Roller
Outer Bearings	Tapered Roller
Adjustment	Spacers (See Text)
Drive Pinion Spacers (Shims)	.375" - .427" (.002" Steps)
Drive Pinion Backlash Adjustment	Shims
Shim Sizes Available 3 @	.005" - .010" - .020"
Pinion & Bevel Gear Adjustment	
Pinion and Bevel Gear Backlash	0.008" - .012"
Method of Adjustment	(See Text)
Axle Housing	
Distortion	1/16" Max.
Axle Shafts	
Drive Flange Run-out Not to Exceed	0.005"
Shaft Run-out at Center	1/16"
Number of Splines	16
Backlash Between -	
Side Gear and Axle Shaft Splines	0.001" - .005"
Diameter - At Splined End	2.372" - 2.377"

Body

Contents of This Section

Related Subjects in Other Sections

GENERAL MAINTENANCE

The body comprises the main structure of the vehicle. Unlike conventional motor cars and trucks, separate frame is not used, all units such as power plant, running gear, steering system, etc., being attached directly to body. Low center of gravity, reduction of weight, and flexibility of structure are achieved through this design without sacrifice of strength.

Since separate frame is not used, all road shock, driving and braking stresses, etc., are absorbed by body framing and outer panels. A small amount of twist or undulation occurs in body, as complete rigidity of the structure is not desirable. It is therefore important that body be regularly inspected for loose rivets and bolts.

Entire vehicle should be regularly inspected for condition of paint and for corrosion damage, with particular attention given to underside. Inspection should be made more frequently in freezing weather due to the corrosive effects of road de-icing materials (salt, calcium chloride, etc.) on metal. If inspection discloses any evidences of corrosion, paint failure, or bare metal, corrective measures as outlined under "Painting" (later in this section) should be immediately employed.

EXTERIOR MAINTENANCE

Both painted surfaces and polished side panels should be protected by a coating of wax, applied at regular intervals. Periods between applications should be sufficiently short to assure continuous protection of the finish. Any good body wax can be used for both painted and polished surfaces. Wax should be applied immediately after coach has been cleaned, by spraying or other means. Wax should be rubbed down either with a lamb's wool polishing wheel or by hand.

Both polished and painted surfaces can be cleaned with mild soap and water. When necessary to remove previous wax coatings, gasoline or similar solvents meeting local fire and health regulations may be employed.

Hard, alumilite finish on fluted side panels is produced by an electrochemical process. Alumilite coating is abrasion-resistant and may be cleaned, if necessary, with a mild abrasive cleaner. However, alumilite like other aluminum, is attacked by many acids and most alkalies. Consequently, considerable care should be taken in the selection of chemical cleaners. Numerous joints in side panels make use of even inhibited alkaline cleaners inadvisable, due to difficulty in removing all traces of cleaner.

INTERIOR MAINTENANCE

Cleaning Painted Surfaces

Clean surface with cloth dampened in gasoline, then rub with polishing compound. Rub with clean cloth until original finish is restored.

Cleaning Rubber

Use soap and water for cleaning rubber. Do not use gasoline, since gasoline attacks rubber.

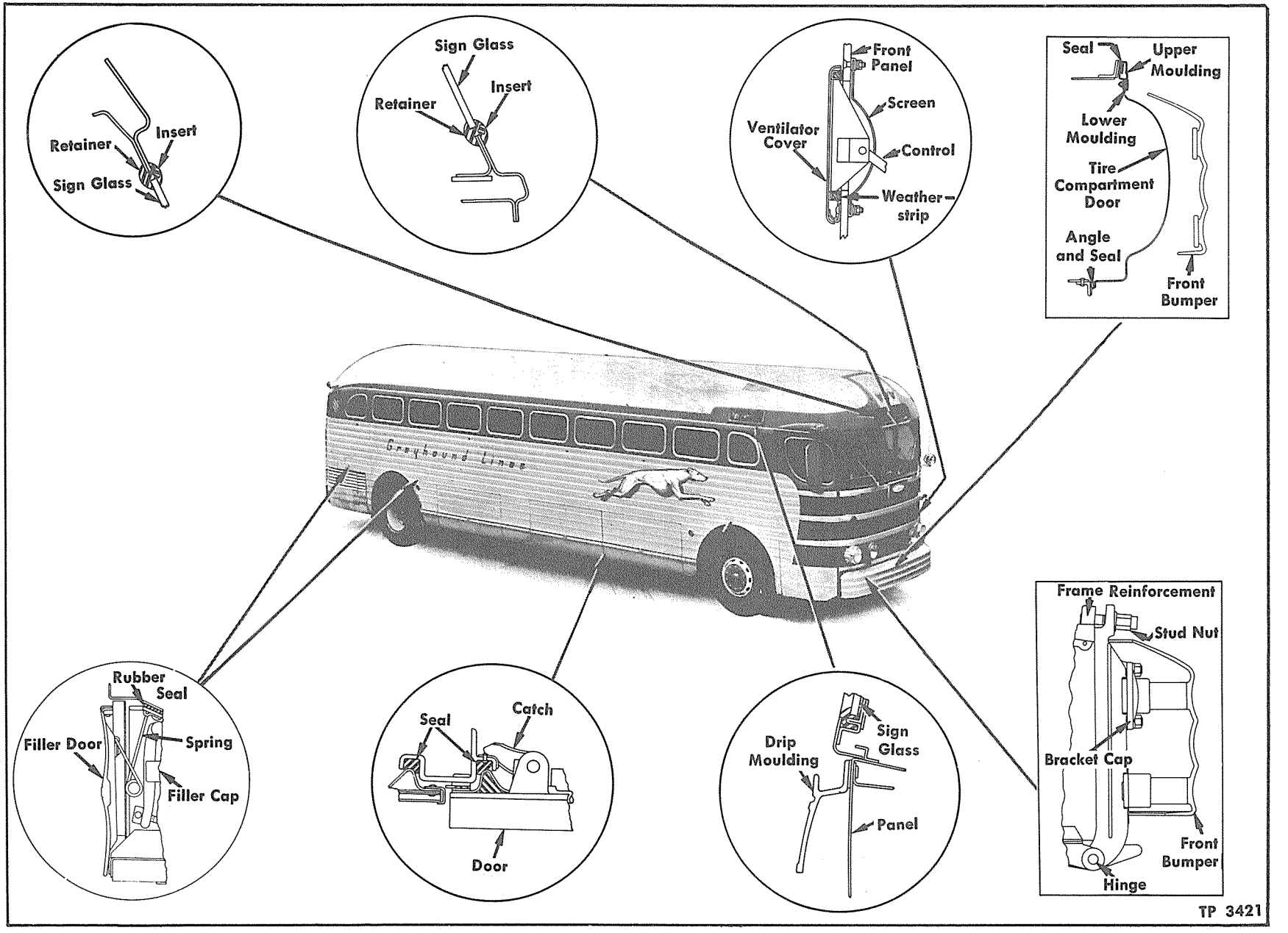

Figure 1—Front Three-Quarter View Showing Construction

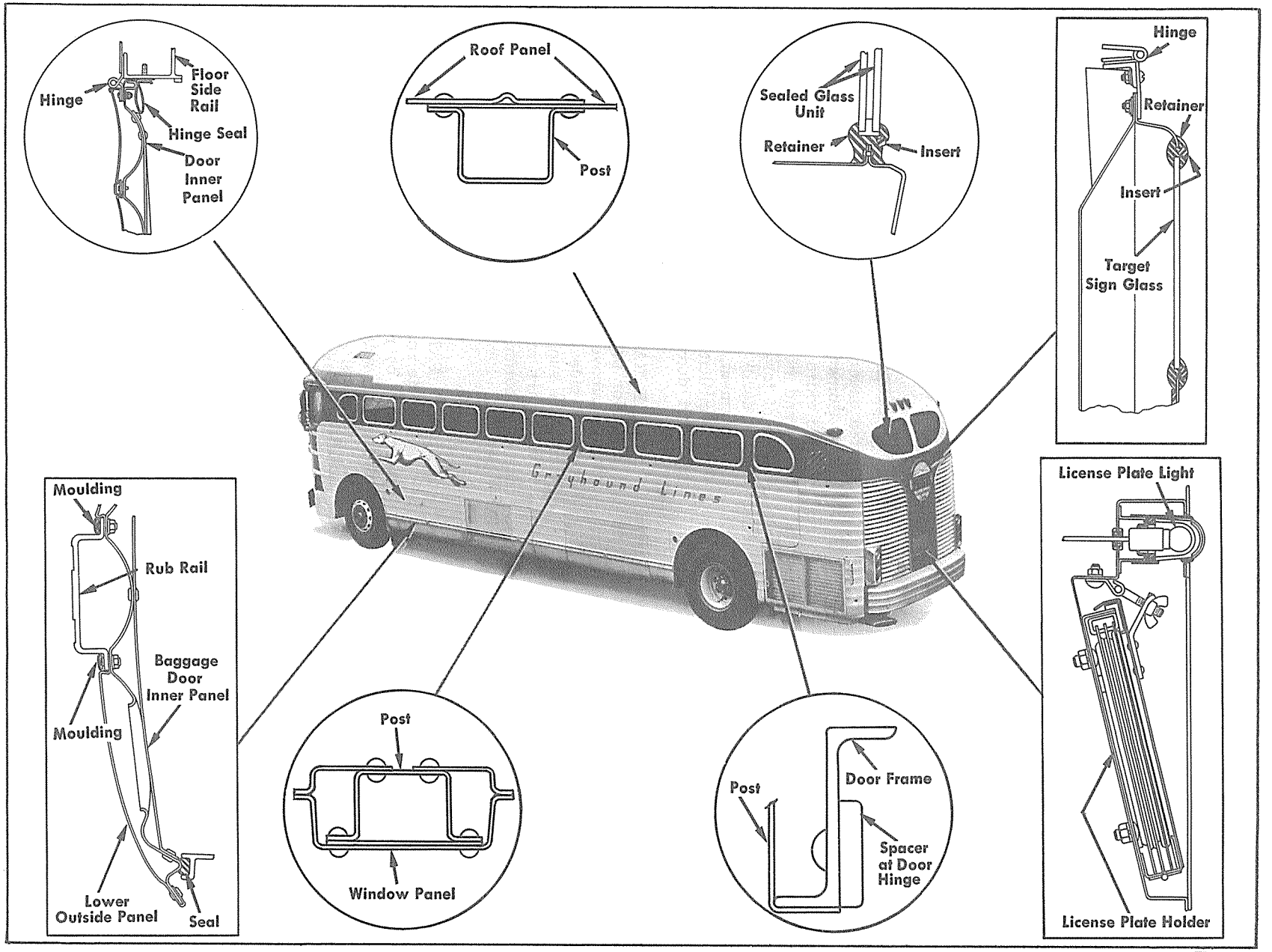

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Figure 2—Rear Three-Quarter View Showing Construction

BODY

Cleaning Metal

Use paint thinner or any good metal polishing compound for unpainted metal surfaces.

Cleaning Window Glass

Use any standard cleaner which does not attack paint. Apply cleaning solution, then rub with cloth dampened in water. Rub with clean cheese cloth until dry.

Cleaning Light Fixture Glass

Semi-frosted glass can be cleaned with commercial muriatic (hydrochloric) acid. Remove glass from coach since acid will damage adjacent parts. Protect hands with rubber gloves and wear goggles. Pour a small amount of acid on glass and rub gently with a clean cloth. Rinse with water and dry before installing in coach.

BODY STRUCTURE

Body and integral underframe are of all-metal construction. Underframe and body are built as a unit forming, in effect, a girder-type structure.

Body is composed of underframe, sides, front end, rear end, floor, and roof. Baggage racks are formed by underframe, floor and sides; inside package racks are suspended from carlines and upper side posts. Engine is mounted in rear of vehicle, supported by roof structure. Some details of body construction are shown in figures 1 and 2.

UNDERFRAMING

Body underframing consists of longitudinal members over front and rear axles, to which running gear is attached. Two longitudinal channels, which form part of front longitudinal members, are also attached to rear longitudinal members. Baggage compartment bulkheads and compartment bulkheads and compartment floor are attached to longitudinal channels. Seat floor is supported by longitudinal members, bulkheads, and floor side rails.

BODY SIDES

Body side is composed of posts, plain side panels, window panels, rub rails, brackets and reinforcements. Sides are attached to floor side rails, bulkheads, and baggage compartment floor. Outer fluted panels are attached to plain side panels. Side includes several small doors for access to batteries, surge tanks and fuel filler caps. Baggage compartment doors are also included, being hinged to floor side rail.

FRONT END

Front end, which contains driver's compartment is composed of posts, panels, and castings. Front end includes front destination sign, windshield, front bumper, spare tire compartment, stepwell and retracting step.

REAR END

Rear end is composed of panels, posts, brackets, castings, rear window, and engine compartment doors. Engine is supported by rear end structure, which also contains electrical control compartment.

ROOF

Roof consists of posts, carlines, panels and drip mouldings. Roof is attached to side posts and window panels, and to front and rear end structures.

BAGGAGE COMPARTMENTS

Three transverse baggage compartments are located under seat floor between front and rear axles. Compartments are accessible through doors in both sides of vehicle. Cooling evaporator (if used) and heating radiator are located in front center of forward compartment. Air conditioning unit (if used) is located in left side intermediate compartment. Radio compartment is also located in intermediate compartment, accessible from front left-hand door.

PACKAGE RACKS

Interior package racks extend along each side of coach above windows. A narrow package rack connects side package racks above rear windows. Racks are supported by roof carlines and posts. Lower part of package racks contain air ducts for distribution of conditioned air to interior of coach.

INTERIOR PANELS

Masonite roof center trim panels are attached to carlines by moulding retainers, held with self-tapping screws. Snap-on mouldings attach directly to retainers. Lower masonite side panels are held at top and sides by mouldings attached with wire clips. Bottom of panels are held in channel of stainless steel kick panel. Kick panel is attached to side posts with self-tapping screws, and is held at bottom by channel in panel which fits over floor covering and floor rail.

EXTERIOR PANELS

Interior panels must be removed for access to exterior panel rivets, Refer to "Interior Panels" for panel removal instructions.

If riveting of exterior body panels is necessary remove moulding strips, then remove screws from upper panel moulding retainers. Seats must be removed before kick panels can be removed. Remove moulding clips carefully from lower panels.

Remove insulation carefully to avoid necessity of replacement due to damage.

To avoid stripping threads, do not over-tighten self-tapping screws. However, if threads are stripped, use existing holes and employ next larger size self-tapping screws.

When installing an exterior panel, seal all points of juncture with other parts with a suitable caulking compound, such as that listed under "Special Materials" at end of this section.

INSULATION

Body sides and roof are completely insulated by means of fibre glass and pads of cellular insulation between inner and outer panels. Engine compartment is coated with sound deadener compound to prevent entry of engine noise, heat, and fumes into body interior. Underside of floor in left side of intermediate baggage compartment is insulated to exclude heat and sound from air conditioning engine.

Side and rear windows are double-glazed to reduce heat transference and prevent fogging.

REPAIR AND REPLACEMENT

GENERAL

In the event of serious collision the Technical Service Department of GMC Truck and Coach Division will furnish dimensional data, sketches, and other information upon request.

Body and underframe can be repaired and replaced by competent craftsmen with proper tools and equipment.

Meanwhile preliminary work can be started, using dimensions given in figure 3 for checking purposes.

REPLACING BODY PARTS

Whenever repairing or replacing aluminum parts, carefully follow accepted and recommended practice. The Aluminum Company of America will furnish, upon request, booklets titled "Riveting Alcoa Aluminum" and "Welding and Brazing Alcoa Aluminum". The booklets explain detailed procedures necessary in the repair and replacement of aluminum parts.

Proper precautions must be observed, particularly with reference to welding, reinforcing, corrosion prevention, and replacement, as follows:

1. Welding of aluminum structural members, or any aluminum parts subject to strain or compression, is not recommended. To maintain proper body strength, replace damaged posts, carlines, and other structural members with new parts obtained from the factory.

2. To prevent galvanic corrosion of aluminum, all surfaces of dissimilar metals in contact with aluminum must be properly coated with paint and/or plating. This also applies to attaching parts such as bolts, washers, nuts, and rivets. Refer to "Repainting Aluminum Parts" and "Painting New Aluminum Parts" later in this section.

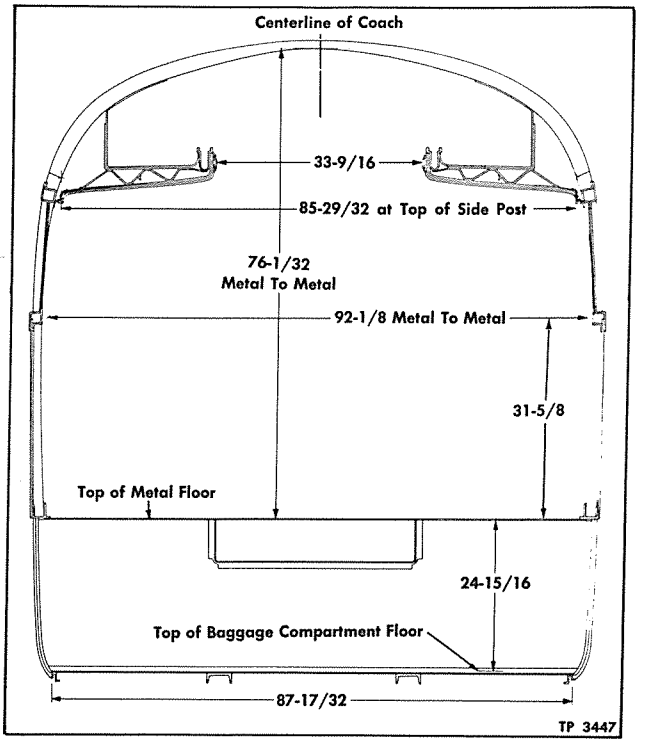


Figure 3—Dimensioned Cross Section of Body

CAUTION: Avoid mixing steel and aluminum structures or parts when making repairs. Do not substitute steel for aluminum in understructure, rub rails, etc., although steel can be used for support fittings for separate units, such as air tanks, control rods, etc. Greater deflection (lower modulus) of aluminum causes steel members to tend to take entire load when used in combination with aluminum parts.

STRAIGHTENING

Use of heat when straightening structural parts of body is not recommended, since heat affects structural characteristics of certain alloys and especially heat-treated parts. Body structural members should be straightened cold; any part bent or buckled sufficiently to show strains or cracks after straightening should be replaced, or properly welded and reinforced.

CUTTING

When cutting a structural member, cut at an angle of 30 degrees. Thus, actual length of cut is twice width of piece being cut, and stress or

BODY

load is distributed over a longer joint when welded. Cutting can be done by torch, although use of saw is preferred, since cut is cleaner and less material is removed.

REINFORCING

CAUTION: Before reinforcing any part of vehicle, determine cause of failure. Body and frame are integral; therefore, driving stresses and strains are transmitted throughout body. Reinforcing a point of apparent failure without correcting underlying cause of failure, may transfer stress to other parts not engineered for such stress, with resultant development of new failures. Since body is designed to "weave", a rigid reinforcement in any part of body may nullify the design of entire vehicle.

Reinforcements can be made of flat, angle or channel stock, whichever is most suitable for purpose. Use of angle reinforcements is recommended due to difficulty in fitting channel reinforcements. Reinforcements should be sufficiently long to distribute load evenly over a considerable area and thickness should not exceed that of member being reinforced. Reinforcements should be riveted to broken part.

RIVETING

Cold aluminum rivets should be used in aluminum parts.

Diameter of rivets should be approximately 100% thickness of plates to be riveted although rivet diameter is also dependent upon spacing and number used.

Replacement of body parts will necessitate removal of rivets in many cases. Rivets can be removed most easily by cutting off rivet head with a sharp chisel, marking center of rivet with a center punch, then drilling out rivet with a drill slightly smaller than body of rivet. Rivet can also be driven out with punch, instead of being drilled out, depending upon type and size of material riveted. If rivet is large, first cut out a groove across center of rivet head with a cape chisel before cutting off head with a flat chisel.

WELDING

Refer to note, earlier in this section, regarding welding of structural parts.

Shielded arc welding is recommended as heat of weld is localized and burning of material minimized with this method. When welding a cut member, fill or weld cut completely. Welding rods should be of substantially same material as parts to be welded.

SEALING

When replacing front, side, rear panels, and particularly roof panels, special attention should be given to proper sealing of joints. Use of the sealing and caulking compound, listed at the end of this section, is recommended wherever necessary to exclude water, dust, cold, and air.

DINGING AND FINISHING

Paint is quickly scuffed off sharp dents leaving bare metal exposed to corrosion. Importance of proper metal finishing to produce a fairly smooth surface should, therefore, not be underestimated. Application of hammer directly to panel tends to stretch the metal unnecessarily. Whenever possible a spoon should be used when bumping a panel. Repair damaged panels by forcing outward in direction opposite to force which caused damage. In this way metal strains set up when damage occurred, are relieved.

PAINTING

Aluminum corrodes just as iron and steel rusts; under certain conditions aluminum will corrode more rapidly than steel. Vehicles should therefore be inspected regularly for corrosion damage and for condition of paint coatings, in order that corrective measures may be applied as necessary.

REPAINTING ALUMINUM PARTS

1. Thorough cleaning is essential. All corrosion products, grease and other foreign matter must be removed. Solvent cleaning, pressure steam cleaning, wire brushing, and hand sanding methods are recommended.

2. Completely remove old paint by use of organic solvents - do not use alkaline paint remover on aluminum. If old primer is very difficult to remove and there is no evidence of metal corrosion, old primer may be left on, but all loose paint must be removed.

3. Apply warm 5% sodium dichromate or potassium dichromate solution (two ounces dichromate in one quart of water) to cleaned surfaces. Apply by spraying. Allow parts to dry.

4. Use a zinc chromate primer such as DuPont 63-1016 or Arco 214-30089 or any equivalent material made by a reputable manufacturer.

Apply primer, preferably by spraying in a very thin coat. Properly applied primer will be greenish in color; yellow color indicates too heavy a coating. If zinc chromate primer cannot be obtained, use of a red oxide primer is recommended, but only as an emergency measure.

5. Apply finish coats:

a. For understructure and other parts not requiring color, apply two coats of the following, or equivalent: Reduce 5 parts of DuPont RC-147 clear Dulux with 1 part Duco #3637 Thinner.

To each gallon add 2 pounds Albron (aluminum) paste, stirring mixture thoroughly.

If synthetic aluminum enamel is not available, any synthetic or other enamel, aluminum lacquer, or other lacquer, in that order, may be used; but only materials made by a reputable manufacturer should be employed. Then apply one heavy coat of asphalt-base sheet-metal deadener approximately 1/32 inch thick. Special spray equipment, including pressure tank, must be used if deadener is applied by spraying.

b. To exposed body parts, apply air-drying surfacer and color coats in accordance with standard practice.

REPAINTING STEEL PARTS

The foregoing procedures may also be applied to steel and iron parts, with following exceptions:

1. Use of phosphoric-base metal conditioner, such as "Metalprep" (Neilson Chemical Co.) or "Deoxidine" (American Chemical Paint Co.) or equivalent, is recommended in preparing steel for painting. These materials vary in method of application and use, and should be employed only as directed by the manufacturer.

2. Both organic and alkaline paint removers may be used on steel parts. However, if alkaline removers are used, all traces of alkali must be washed off before primer is applied.

3. Oxide-type primer is recommended for use on steel parts, instead of zinc chromate primer. Zinc chromate primer should not be used on steel unless parts have been slightly roughened by sanding.

PAINTING NEW ALUMINUM PARTS

When installing new aluminum parts, or new parts which contact with aluminum parts in assembly, succeeding procedures should be followed:

1. Remove from vehicle old parts to be replaced.

2. Treat all exposed sides of adjacent parts remaining in body according to instructions in paragraphs 1, 2, 3, and 4 under "Repainting Aluminum Parts" if aluminum; if steel treat as in paragraphs 1, 2, and 3 under "Repainting Steel Parts."

3. Prime coat all sides of new parts to be installed as outlined in paragraph 4 of "Repainting Aluminum Parts," and paragraph 3 of "Repainting Steel Parts." Use only zinc or cadmium coated bolts, washers, and nuts. Dip all bolts, nuts, washers, and rivets in primer and allow to dry.

4. Install new parts, then apply finish coats as outlined in paragraph 5 of "Repainting Aluminum Parts."

PAINTING NEW STEEL PARTS

The above procedures may be applied to new steel and iron parts except that oxide base primers are recommended in place of zinc chromate type.

NEW VEHICLES

CAUTION: Vehicles delivered in surfacer, with color coats omitted, should be painted immediately upon receipt of vehicle. Primer and surfacer coats afford little protection against corrosion. Main purpose of primer is to bond succeeding coats to metal while surfacer coat is used only to smooth out any roughness in surface. Both primer and surfacer coats are porous in nature; severe chalking will occur rapidly, with possible flaking during freezing weather, unless vehicle is promptly painted.

Due to deterioration of surfacer, accumulation of road film, etc., while in transit, satisfactory coating and prevention of corrosion can be achieved only by proper preparation.

1. Wash vehicle thoroughly with clear water, using no soaps or chemical cleaners.

2. Thoroughly sandpaper surfacer, using dry paper of light weight grit, preferably 350-400 grade. If vehicle has been in service, it will be necessary to remove virtually all of the original surfacer by sanding.

3. Apply a coating of a good grade of surfacer and allow to dry thoroughly (at least 8 hours, preferably longer). Sand surfacer, using sandpaper of 350-400 grit.

4. Apply color coats in accordance with standard practice.

DOORS AND CONTROLS

Vehicle has two passenger doors - front entrance and emergency. Both doors are sedan type, hinged at front, and open outwardly.

ENTRANCE DOOR MECHANISM

Entrance door is hand-operated type controlled by handle on windshield ledge. Door operating mechanism is illustrated in figure 4. Mechanism is so designed that door is locked firmly in either fully open, or fully closed positions. Door, however, can be opened from outside by pressing door lock release button, located on outside of front panel below front emblem light. Pressing release button forces lock past center, releasing door.

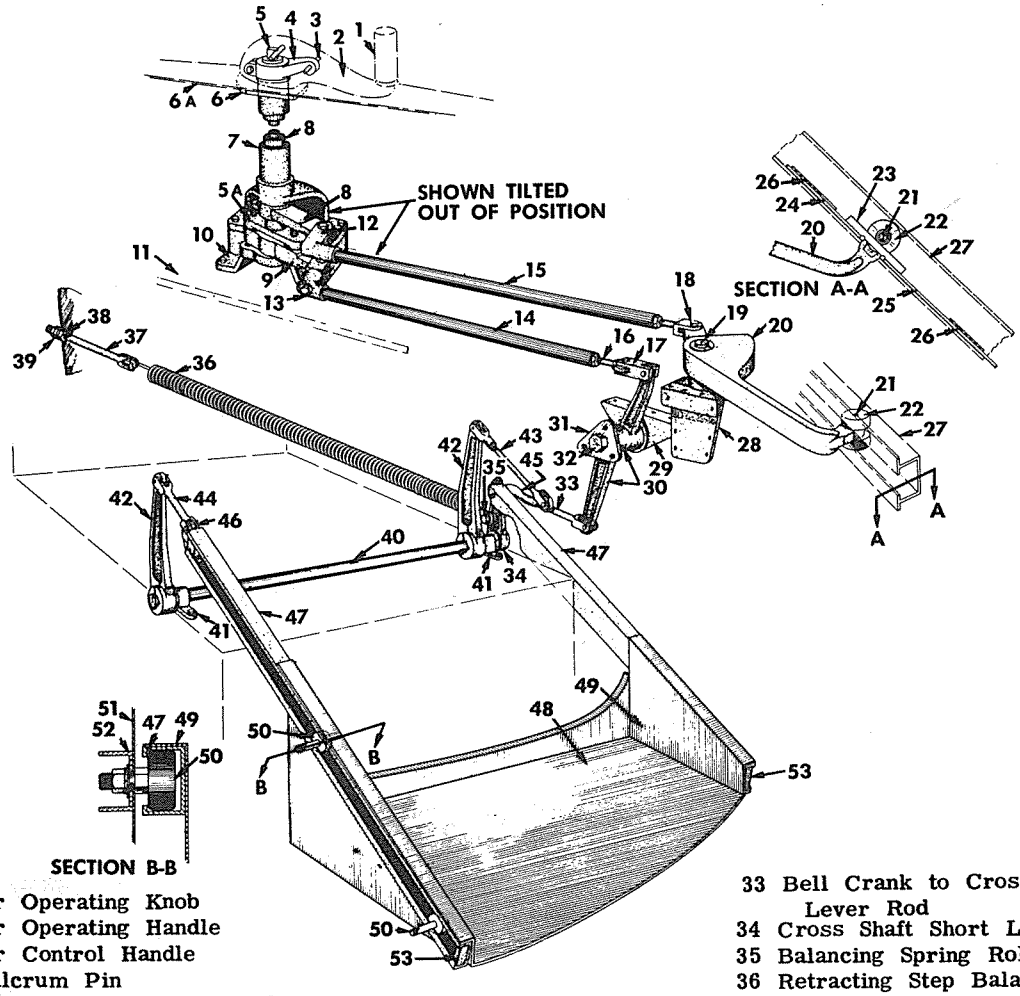
Door can be operated either independently or in conjunction with retracting step.

OPERATION

(Key Numbers Refer to Figure 4)

Door is opened and closed by rotating knob (1). Motion of handle (2) turns door control tube

BODY



1 Door Operating Knob
2 Door Operating Handle
3 Door Control Handle Fulcrum Pin
4 Door Control Handle Level
5 Retracting Step Lift Rod
5A Door and Step Control Interlock
6 Door Control Shaft Bracket
6A Windshield Ledge
7 Control Rod Housing Tube
8 Door Control Tube and Lever
9 Step Control Lever
10 Door and Step Control Bracket
11 Front Compartment Floor Sheet
12 Door Operating Rod Yoke
13 Step Operating Rod Yoke
14 Step Operating Rod
15 Door Operating Rod
16 Step Control Tube Screw Eye
17 Step Control Yoke
18 Door Operating Lever Yoke
19 Door Operating Lever Shaft
20 Door Operating Lever
21 Door Operating Lever Roller Pin
22 Door Operating Lever Roller
23 Door Operating Lever Seal Shoe
24 Door Operating Lever Front Seal
25 Door Operating Lever Rear Seal
26 Door Operating Lever Seal Guide
27 Door Roller Track
28 Door Operating Lever
29 Bell Crank Front Bracket
30 Step Control Bell Crank
31 Bell Crank Shaft Rear Bracket
32 Bell Crank Through Bolt
33 Bell Crank to Cross Shaft Lever Rod
34 Cross Shaft Short Lever
35 Balancing Spring Roller
36 Retracting Step Balancing Spring
37 Retracting Spring Eye Bolt
38 Spring Eye Bolt Adjusting Nut
39 Spring Eye Bolt Lock Nut
40 Step Operating Cross Shaft
41 Cross Shaft Bearing
42 Operating Lever
43 Front Operating Lever Rod
44 Rear Operating Lever Rod
45 Front Track Operating Bracket
46 Rear Track Operating Bracket
47 Step Roller Track
48 Step Bottom Plate
49 Step Side Plate
50 Step Roller and Bearing
51 Front Underframe Bulkhead
52 Roller Reinforcement
53 Roller Track Stop

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Figure 4—Entrance Door and Retracting Step Mechanism

and lever (8), transmitting movement through yoke (12) to operating rod (15). Operating rod actuates door operating lever (20), moving roller (22) in track (27) to open or close door.

Retracting step is operated in conjunction with door by pressing downward on knob (1) while rotating handle (2). Downward pressure on knob (1) causes handle (2) to fulcrum on pin (3) raising retracting step lift rod (5). Lift rod moves door and step interlock (5A) engaging pins in holes in door control tube and lever (8). Step control lever (9) and door control tube and lever (8) are now locked together by means of interlock (5A).

With door and step mechanisms interlocked, door operates as previously described. In addition, rotation of handle (2) operates step control lever (9) moving step operating rod (14) and rotating step control bell crank (30). Movement of bell crank is transmitted through lever rod (33) and short lever (34) to operating cross shaft (40). Cross shaft (40), in turn, moves step on rollers (50) through long levers (42) and operating lever rods (43 and 44). Weight of retracting step is balanced by spring (36).

MAINTENANCE

Door and step mechanism requires no maintenance other than occasional sparing lubrication. All major points of friction, including step rollers, incorporate sealed - type roller bearings. Other points, however, should be lubricated.

ADJUSTMENT (Key Numbers Refer to Fig. 4)

Door operating rod (15) is adjusted by disconnecting operating lever yoke (18), loosening lock nut, then turning yoke (18) to lengthen or shorten rod. Yoke is accessible through safety equipment compartment door in dash panel. Whenever adjustment is made, be sure that mechanism locks over center in both fully opened and fully closed positions of door. In either position, it should not be possible to move door unless handle is first moved out of locking position.

Step operating rod (14) is provided with means of adjustment to obtain synchronous operation of door and step. Adjust by disconnecting screw eye (16) from yoke (17), loosening lock nut, and turning yoke (17) as necessary to shorten or lengthen operating rod. Yoke and screw eye are accessible through safety equipment compartment door in dash panel. Adjust so that step is fully extended with door fully open; operating bracket (46) must "bottom on roller (50).

Front operating rod (43) is adjustable for alignment of step tracks with rollers. If step moves or "cocks" when weight is applied to step, rod (43) should be adjusted. Rod (43) is accessible from underneath coach with step in fully extended position.

Tension of balancing spring (36) is varied by nuts (38 and 39) which are accessible through opening after removal of left-hand fog light.

RETRACTING STEP REMOVAL

Retracting step can easily be removed, if damage to step prevents closing door (fig. 4).

With step extended, remove bolts and nuts which attach front track operating bracket (45) to front roller track (47). Bracket bolts are accessible from underneath coach.

Open triangular cover plate in rear side of stepwell. Through opening, remove two bolts and nuts which attach rear track operating bracket (46) to rear roller track (47). Step is removed by pulling downward and outward.

ENTRANCE DOOR

Entrance door (fig. 5) is composed of aluminum panels and framing. Door requires no maintenance other than regular lubrication of hinges and periodic inspection of seals.

Mirror brackets are attached to door. Brackets are so designed that pressure on outer edge of mirror causes mirror to swing parallel to door, thus permitting use of automatic washing equipment.

Step light, shown in figure 5, is covered in Lighting System (Sec. 7G of this manual).

Entrance door window is opened and closed by hand-operated regulator. Regulator is double-arm type, designed to hold window securely in any desired position. Replacement of window glass is covered under "Glass Replacement" later in this section.

EMERGENCY DOOR

Emergency door is located on left-hand side of coach, immediately back of rear wheel. Door, which is hinged at front and opens outward, is equipped with a manually-operated locking lever mechanism.

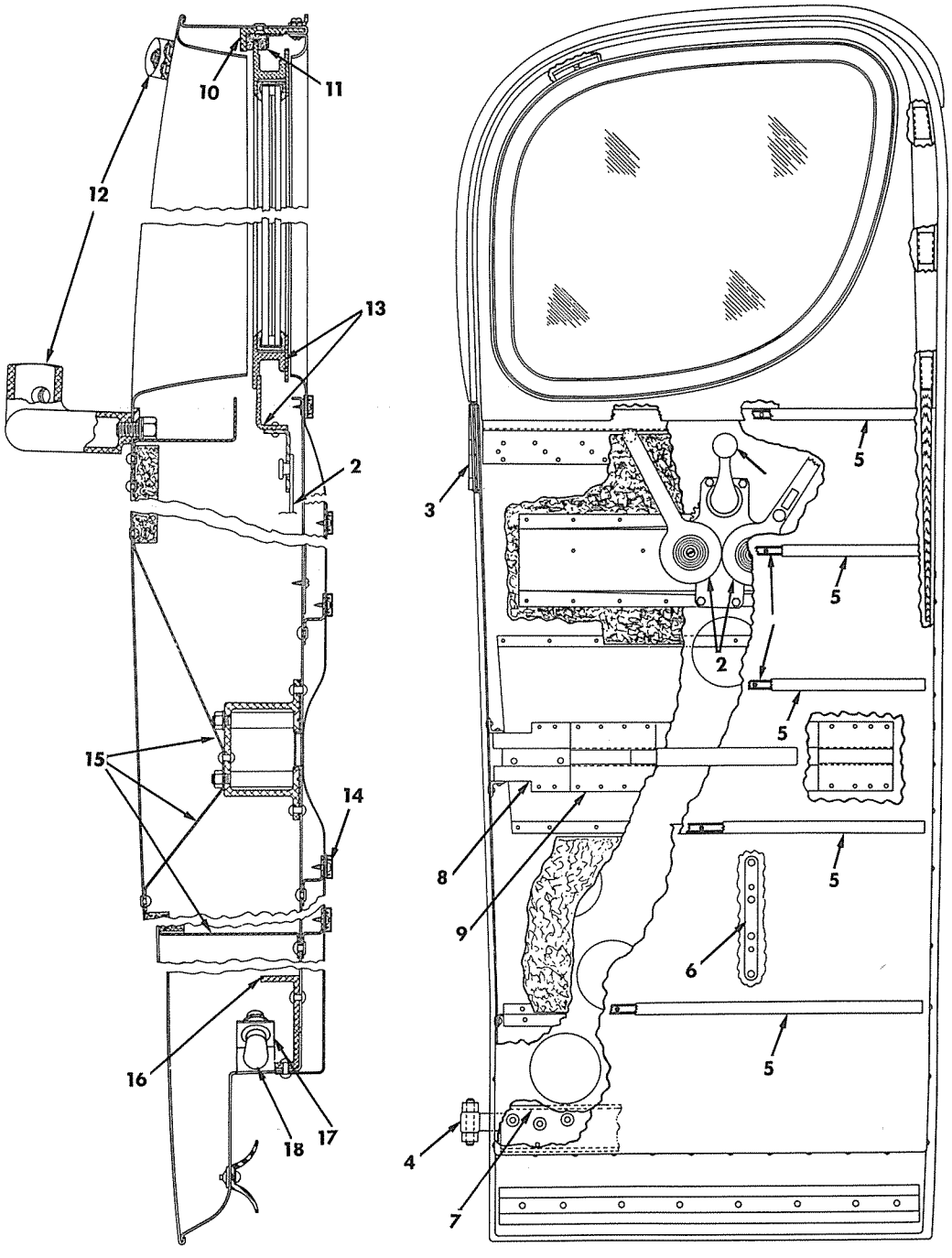
Door requires no maintenance other than periodic inspection of seals, and occasional sparing lubrication of hinge and locking mechanism. Emergency door should be tested daily to make sure of proper operation of door, lock, and warning signals.

EMERGENCY DOOR SWITCH

Emergency door switch is mounted on door lever catch, movement of which closes switch contacts. Whenever door is not closed or atched, switch completes circuit to emergency door telltale and alarm buzzer.

Refer to Wiring and Miscellaneous Electrical (Sec. 7A of this manual) for maintenance and repair information, and to wiring diagrams in that section for switch electrical circuits.

BODY



1 Window Regulator Handle
2 Window Regulator
3 Upper Hinge
4 Lower Hinge
5 Moulding
6 Reflector Spacer (Outside of Door)
7 Channel
8 Door Roller Track
9 Guide
10 Window Frame
11 Window Channel
12 Mirror Brackets
13 Sash
14 Moulding Retainer
15 Reinforcement Panels
16 Channel
17 Bracket
18 Step Light Bulb

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Figure 5—Front Entrance Door Construction

SASH AND GLASS

RUBBER INSERT RETAINED GLASS

A special insert-type rubber retainer is used to install glass in front destination sign, windshield, rear windows, and target sign. It should be noted that rear window glass is a double-glazed sealed unit; however, removal and installation instructions are also applicable to this unit.

Although possible to install retainer and seal insert without use of special tools, tools listed in "Special Tools" at end of this section, are recommended to facilitate installation (fig. 6).

GLASS REMOVAL

1. With pointed tool raise one end of insert out of groove in retainer seal, then pull insert from seal by hand.
2. Push glass outward from inside vehicle; an assistant outside should prevent glass falling.
3. Remove rubber retainer seal from panel by hand.

GLASS INSTALLATION

1. Straighten panel flange around opening to assure a good fit in retainer seal groove.
2. Cut new glass to provide following clearance between glass and panel opening on all sides:

Location	Clearance
Front Destination Sign	9/32"
Windshield	19/64"
Target Sign	9/32"

3. Position retainer seal in panel cut-out, making sure seal is pushed into place in corners. Ends of seal should come together at side of opening near top.
4. Cut off retainer seal ends, allowing sufficient overlap to secure a tight joint and carefully butt into position.
5. Apply soap solution to glass groove in retainer seal to facilitate glass installation.
6. Position glass to seal, insert end of retainer seal installer (fig. 6) in seal groove and move tool along edge of glass forcing outer lip of seal over glass. Use large installer (hook) (part of CS-1154-A) for all except rear window. For rear window use special installer (hook) CS-1154-12.
7. Thread end of rubber insert through seal insert installer (fig. 5). At point opposite joint in retainer seal, push tool loop and end of insert into seal groove. Feed into groove in retainer seal. Use a hitching motion to prevent elongation of insert. Use large installer (7/16" eye, part of CS-1154-A) for all installations.
8. Cut off insert, allowing overlap, and butt ends tightly into groove.

SIDE WINDOW SASH

All side window sash is equipped with sealed double-glazed windows. A drying agent is incorporated between the two panes to absorb moisture, preventing fogging and steaming between the outer and inner panes. Design is such that breakage of either pane will necessitate replacement with a complete sealed glass assembly.

Emergency Escape

Side window sash is hinged to body at bottom of sash to provide passenger escape under emergency conditions. Sash is held in closed position by spring-loaded latches at top. A strong push against top of window overcomes latch springs and causes window to swing outward and downward against body side. CAUTION: Window should be opened in this manner only during an emergency, since damage to body side, sash frame, or glass usually results.

Cleaning

Both interior and exterior surfaces of windows may be cleaned from outside of coach. Metal eye on top outer part of sash frame can be engaged with a hook. Pulling sharply on hook opens window, providing access to inside of glass.

Tension of latches can easily be adjusted from outside vehicle. Use screwdriver to reach adjusting screws under roof side drip moulding.

Ventilation

Side windows can be opened for ventilation in event of failure of air-cooling unit. Each window regulator must be individually unlocked with

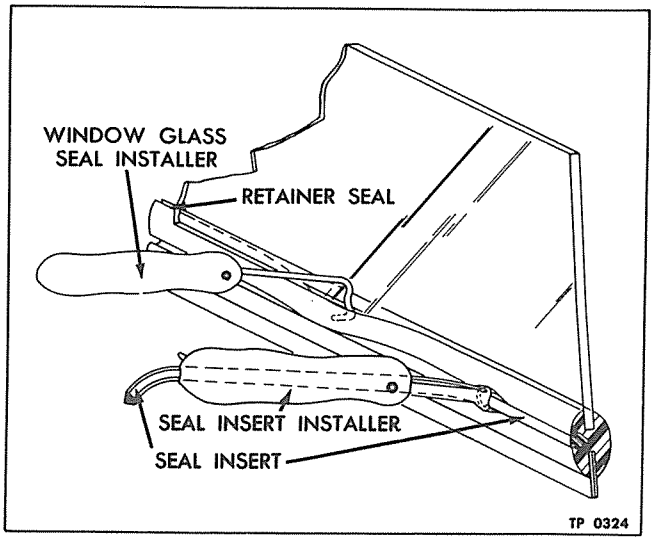

Figure 6—Installing Glass Rerainer Seal and Insert

BODY

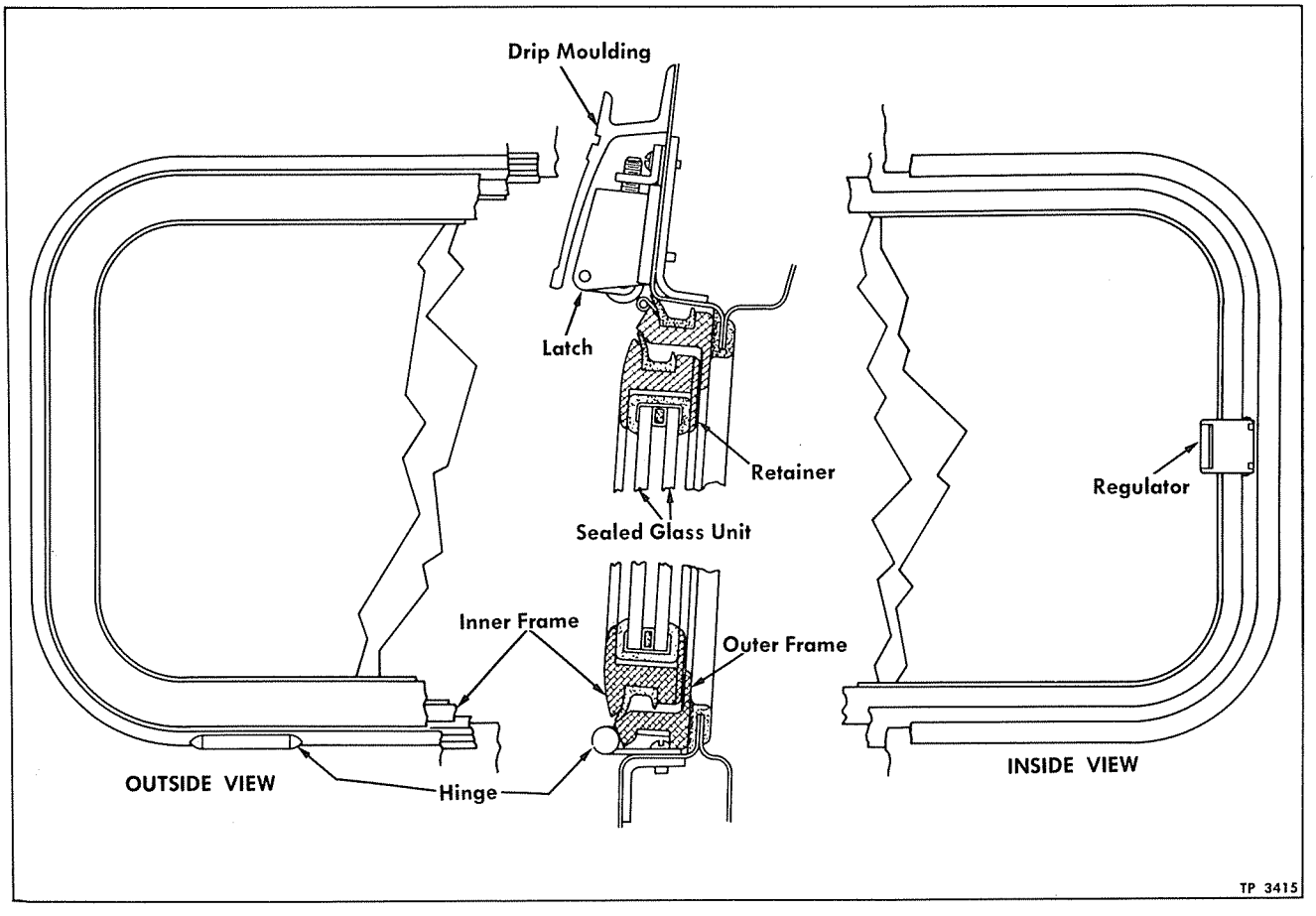

Figure 7—Side Window Sash

driver's key. Rear of window can then be opened outward approximately 1-1/2 inches, this being limited by regulator. When window is closed, spring lock in regulator automatically engages. Window cannot be opened unless again unlocked with driver's key.

GLASS REMOVAL

1. Engage hook in eye at outer top of sash. Open window by pulling sharply on hook.
2. Unlock regulator with driver's key. Open window regulator to remove regulator tension.
3. Support inner frame and remove two screws which attach regulator to outer frame. Remove four screws which attach inner frame hinges to outer frame.
4. Position inner frame on bench for disassembly. Remove screws which attach glass retainer to frame.
5. Remove glass retainer from frame, then remove glass.

GLASS INSTALLATION

1. Clean glass channel thoroughly then position glass in frame.
2. Position glass retainer in frame and install attaching screws. Tighten screws evenly and firmly.
3. Position inner frame in outer frame and install four hinge screws.
4. Position regulator to outer frame and install two attaching screws.
5. Swing window upward into closed position. Make sure that latches have correct tension; adjust, if necessary.

SASH REMOVAL

Entire sash is readily removed after opening window to emergency escape position. Pry small spring-loaded pin from hinge pin with screwdriver. Hold small pin while sliding sash to side. Sash is free when hinge pins are disengaged.

ENTRANCE DOOR WINDOW

Window is raised and lowered by a manually-operated regulator. Double-arm regulator is designed to hold window in any desired positio
Window is double-glazed, and incorporates a

ing agent between the panes to absorb moisture and prevent fogging. Glass is supplied as a sealed assembly, complete with rubber channel. In the event of breakage of one pane, a new sealed assembly must be installed.

DOOR WINDOW GLASS REMOVAL

1. Crank door window down. Remove upper snap-on garnish moulding, then remove moulding retainer.
2. Remove screws from lower edge of upper inside panel. Remove screws, bolts, and nuts which attach upper inside panel to door header, and remove panel.
3. Crank door window completely up. Remove screws from glass retainer then remove retainer. Remove glass from sash frame.

DOOR WINDOW GLASS INSTALLATION

1. Make sure frame channel is clean then position glass in channel.
2. Position glass retainer in sash frame and install attaching screws.
3. Position upper inside panel in door and install attaching screws, bolts, and nuts.
4. Attach garnish moulding retainer then install snap-on garnish moulding.

DOOR WINDOW SASH REMOVAL

1. Remove upper garnish mouldings and moulding retainers. Crank window down.
2. Remove screws, bolts, and nuts which attach upper inside panel, then remove panel. Remove upper trim panel from door.
3. Remove 11 screws from sash channel retainer, then remove retainer. Remove exposed screws from sash channel then crank window up.
4. Remove screws from lower ends of sash channel. Tilt top of sash with sash channel inward, to clear door header.
5. Crank regulator up as far as possible. Disengage regulator cams from sash, then remove sash with channel from door.

DOOR WINDOW SASH INSTALLATION

1. Position sash channel on sash. Slide channel and sash down into door.
2. Engage regulator cams in horizontal slots in sash. Crank regulator down far enough to position sash channel in door.
3. Install screws in sash channel. Position sash channel retainer and install attaching screws.
4. Make sure of free operation of sash before proceeding. Install upper trim panel.
5. Position upper inside panel and install attaching screws, bolts, and nuts.
6. Attach garnish moulding retainers then install mouldings.

DRIVER'S WINDOW

Window is raised and lowered by manually-operated regulator. Double-arm regulator is designed to hold window in any desired position. Window is double-glazed, and incorporates a drying agent between the panes to absorb moisture and prevent fogging. Glass is supplied as a sealed assembly, complete with rubber channel. In the event of breakage of either pane, complete sealed assembly must be installed.

DRIVER'S WINDOW SASH REMOVAL

1. Remove horizontal snap-on moulding below window, then remove moulding retainer.
2. Crank window down. Remove screws from lower edge, sides, and top of window garnish moulding, then remove moulding.
3. If only glass is to be removed, take out glass retainer screws, remove retainer, then remove glass from sash frame. Otherwise, proceed as follows:
4. Remove sash channel screws, then pull top of channel inward. Crank window up while pulling top of window inward.
5. When regulator reaches maximum upward travel position, disengage regulator cams from slots in sash. Pull sash with channel from window opening.

DRIVER'S WINDOW SASH INSTALLATION

1. Position sash channel on sash, then slide both down far enough to engage regulator cams in slots in sash.
2. Crank window down, position channel in opening and install channel screws.
3. Position window garnish moulding to window opening, then install attaching screws.
4. Install snap-on moulding retainer, then install moulding.

MISCELLANEOUS EQUIPMENT

WINDSHIELD WIPERS

Two air-operated windshield wipers are mounted in front panels, below windshield. Air pressure for wiper operation is supplied by the auxiliary air system, fed, in turn, from the vehicle air system. A pressure regulating valve, interposed in air lines, prevents depletion of main air system by shutting off air to auxiliary air system when pressure in main system falls below approximately 65 pounds. Wiper speed is controlled by dual or single (spec. eqpt.) control valves mounted

BODY

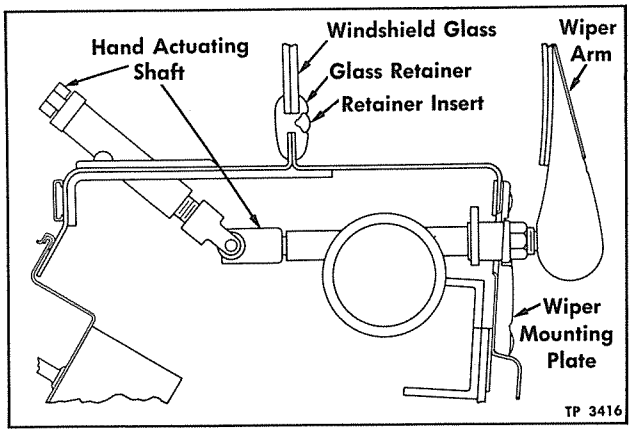

Figure 8—Windshield Wiper Mounting

on instrument board at left of gauge panel.

Refer to Air Brakes (Sec. 4B of this manual) for air line diagrams and information on air lines and connections, including maintenance and repair information on pressure regulating valve.

CONTROL VALVE

Windshield wiper control valve is fitted with an adjustable "stop-knob" to prevent operation of wiper at excessive speeds, with resultant rapid wear of motor. To adjust, loosen two set screws and pull knob off valve. Adjust regulator screw to provide proper motor speed, making due allowance for slower speed if adjustment is made with windshield dry. When correct adjustment is obtained, position stop knob on regulator screw, being careful that adjustment is not disturbed. Tighten knob set screws firmly, while pressing knob against valve body. If adjustment is properly made, knob will "bottom" on valve body, when wiper motors operate at maximum desired speed.

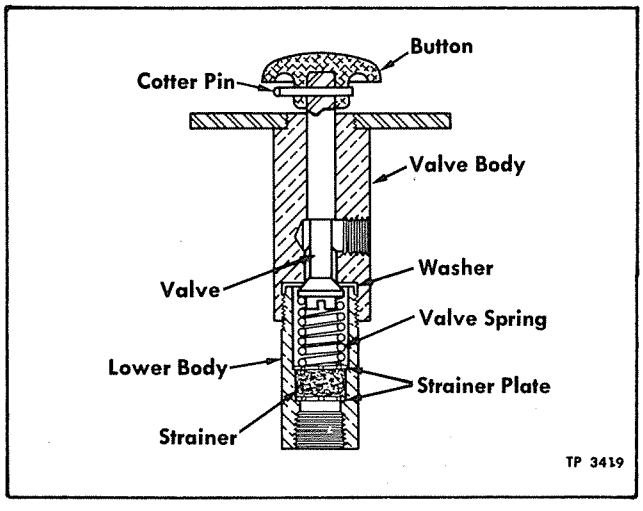

Figure 9—Air Horn Foot Valve

HAND ACTUATING MECHANISM

Hand mechanism (fig. 8) permits driver to keep left-hand windshield clear in the event of wiper motor failure. Mechanism requires no maintenance other than occasional sparing lubrication.

MAINTENANCE

Windshield wiper motors are designed to require no special maintenance and should remain undisturbed unless motors fail to function. Before replacing motors, check all tubing, connections and control valves for leaks or plugging.

REPLACEMENT

Windshield wiper motors are easily replaced, being attached to mounting plates removable from outside coach (fig. 8). Mounting plate is attached to front panel with eight oval head screws. Motor is attached to mounting plate with two hex head cap screws and lockwashers.

When installing motor make sure mounting plate gasket is in good condition. Coat both sides of gasket with a thin layer of a suitable sealing and caulking compound, such as that listed at end of this section.

AIR HORNS

Dual air horns are mounted on bracket located in horn compartment. Horns are accessible from underneath left front corner of coach. Air pressure to horns is controlled by driver's foot control valve. Air pressure is supplied by auxiliary air system, obtained in turn, from main air system. Pressure regulating valve in air lines prevents depletion of main air system by shutting off air to auxiliary air system when pressure in main system falls below approximately 65 pounds.

Refer to Air Brakes (Sec. 4B of this manual) for air line diagrams and information on air lines and connections. Pressure regulating valve maintenance and repair information is also contained in that section.

REPAIR

Sound is produced by stainless steel reed vibrating between two seats. Seats are separated 1/32", this spacing being maintained by a gasket.

Horn is non-adjustable, and requires no maintenance.

In the event of horn failure, make sure that air system pressure is at least 75 lbs. Sticking reed may be cause of failure; usually reed can be freed without removing horn from vehicle. Tap reed through back opening of horn while assistant operates driver's foot control valve intermittently. If this fails to free reed, removal and disassembly of horn is necessary. Seats can be

cleaned with a flat oil stone. Since reeds act as air valves, reeds must be flat. If not flat, replace reeds.

FOOT CONTROL VALVE

Valve, which controls operation of air horns, is mounted in driver's floor, with valve body extending downward into tool compartment (fig. 9). Valve requires no maintenance, but can be easily checked for leakage with soap and water solution.

If leakage does occur, valve should be disassembled and lapped, using fine valve grinding compound. After grinding, wash all parts in gasoline and blow with compressed air to remove all traces of grinding compound.

Whenever valve is disassembled, or in event of weak horn action, curled hair strainer in lower body should be cleaned. Lower body is threaded into valve body, and is removed by unscrewing.

PASSENGER BUZZER AND SWITCHES

Passenger buzzer (fig. 10) is mounted on left side of buzzer and relay panel, located back of driver's switch panel. Buzzer is sounded by switches mounted under package racks near front. Switches are operated by pull cords at top of side windows. Buzzer circuit, fed through "Run" position of engine control switch, is protected by No. 4 fuse in instrument panel. Buzzer electrical circuit is shown in wiring diagram in Wiring and Miscellaneous Electrical (Sec. 7A of this manual).

MAINTENANCE

Buzzer and relay panel, on which passenger buzzer is mounted, is accessible by removing instrument board switch panel. No regular maintenance of buzzer is recommended due to difficulty of access. Consequently, whenever switch panel is removed, buzzer cover should be removed, points inspected and, if necessary, cleaned with fine crocus cloth. Contact points should also be adjusted, if necessary (fig. 10).

Buzzer switches require no maintenance; however snap-on cover is easily removable for inspection and cleaning of contacts.

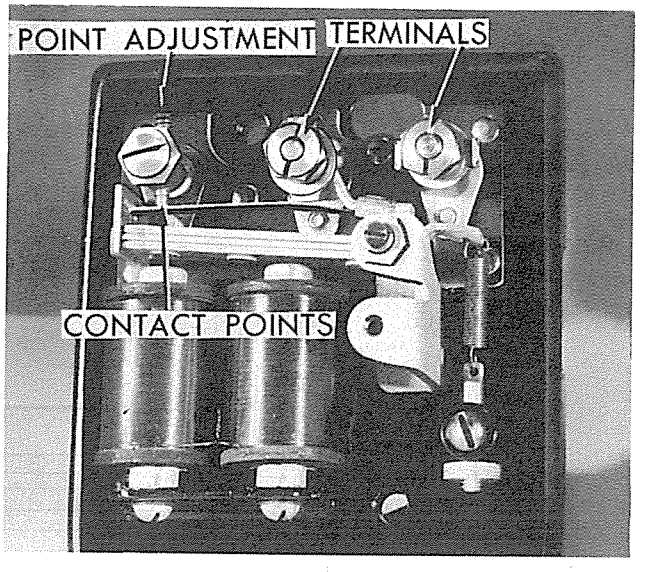

Figure 10—Passenger Buzzer

TEST

If buzzer fails to operate with either switch, first make sure that No. 4 instrument panel fuse is not blown. Check circuits as follows, using voltmeter or test light having a 12 volt 1.5 candlepower bulb:

1. Turn engine control switch to "Run" position. Ground one test lead and touch other to both ends of No. 4 fuse. If no current indication is obtained at either point, check for open circuit in feed to fuse. If current is obtained at only one point, fuse or fuse clips are defective.

2. With a jumper wire, ground No. 22 junction on instrument panel junction panel. If buzzer sounds trouble is probably in switches or in wiring to switches. If buzzer does not sound; trouble is probably in buzzer.

3. Remove buzzer cover and make sure points are clean and in contact. Ground one test lead and touch other to buzzer terminals while holding points open. Current should be obtained at one terminal. Ground other (dead) terminal with a jumper wire.

4. If buzzer sounds, check circuit continuity from buzzer through switches to ground. If buzzer does not sound, remove buzzer for repair or replacement.

HEATING AND VENTILATION

Coaches are equipped at the factory with a standard heating and ventilating system. Provision is made for later installation of cooling (air conditioning) equipment. Since coach manufacturer does not install cooling unit, no attempt is made to cover cooling equipment as a system, in this manual. Some components of the heating ventilating system are common to both heating and cooling systems. Consequently certain units of the cooling system (blowers, ducts, electrical, etc.) are covered herein, but only as these items relate to the heating and ventilating systems.

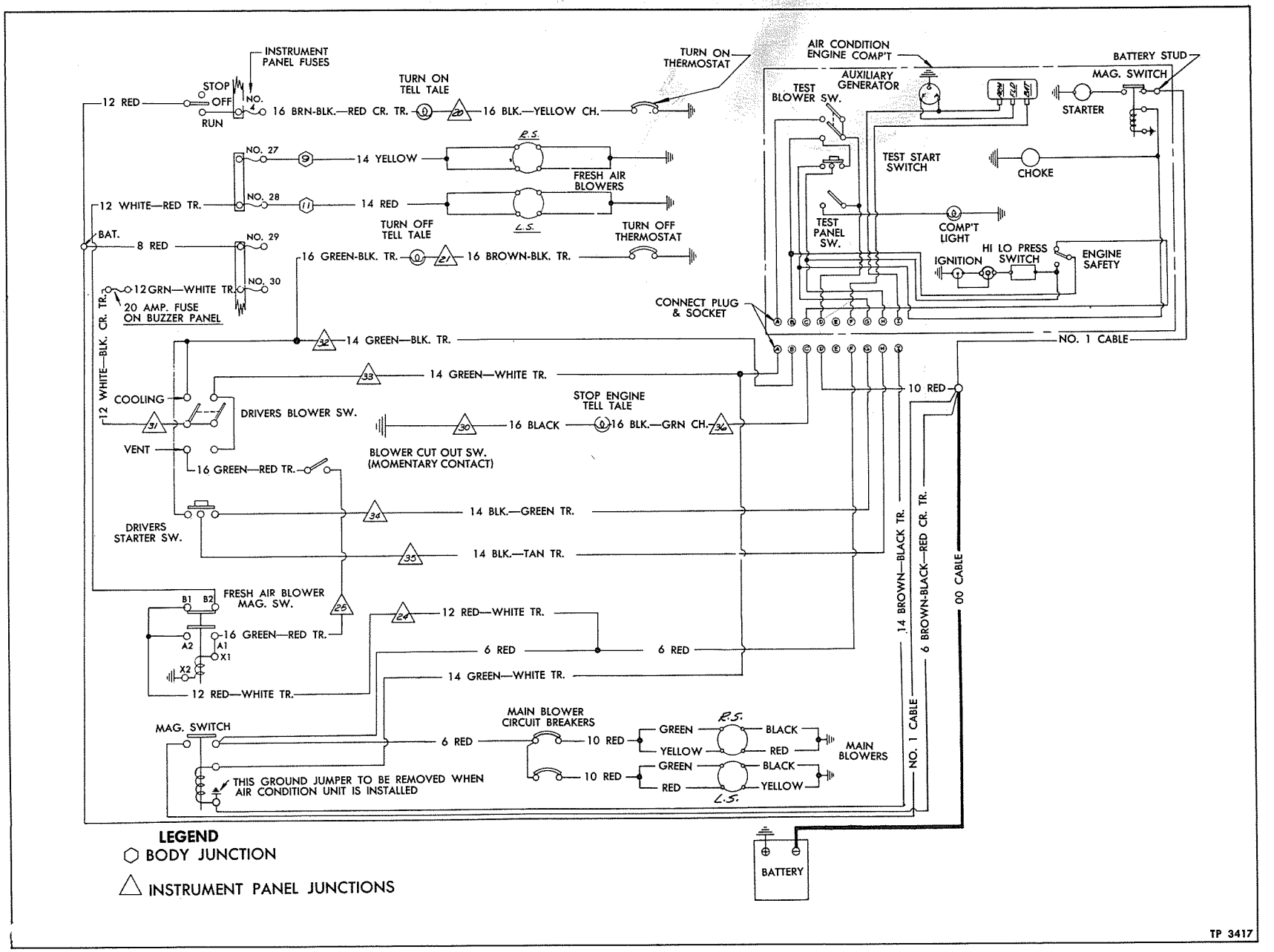

Figure 11—Heating and Ventilating Wiring Diagram

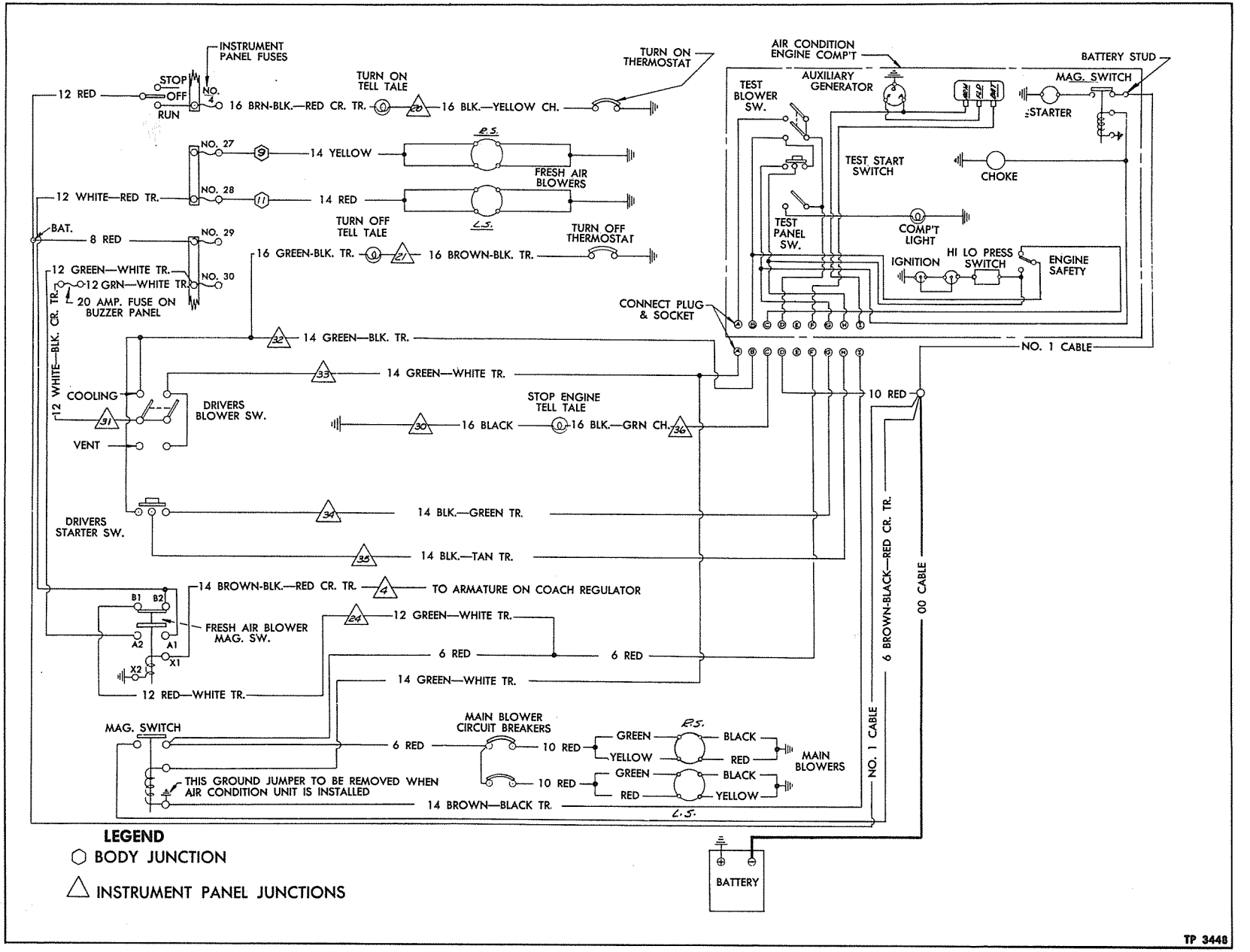

Figure 12—Heating and Ventilating Wiring Diagram (N.Y. Regulation)

BODY

VENTILATION

Coach ventilation is normally accomplished by motor-driven blowers. However, in event of failure of ventilating system, coach may be ventilated through driver's ventilator, driver's window, entrance door window, and side window sash.

DRIVER'S VENTILATOR

Controlled from driver's compartment, ventilator is mounted in left side of front panel. Open ventilator periodically and clean screen by blowing compressed air outward from inside coach. Inspect seal from outside vehicle and replace when vecessary. Use good grade of cement to attach new seal.

DRIVER'S WINDOW

Driver's window may be raised or lowered as desired by means of manually-operated regulator. Regulator requires no maintenance.

ENTRANCE DOOR WINDOW

Entrance door window is opened and closed by means of a manually-operated window regulator. No maintenance is required.

SIDE WINDOW SASH

Driver must open lock on each window with key before window can be opened. Sash is hinged at front; after unlocking rear of sash may be moved outward approximately 1-1/2 inches.

AIR CIRCULATION

CONDITIONED AIR

Air is circulated in coach by two main (evaporator) blowers. Blowers are mounted on front longitudinal members forward of baggage compartment front bulkhead. Conditioned air is forced by blowers forward through two longitudinal ducts. Air in left-hand duct flows under driver's seat to inner half of vertical duct at No. 1 post. Air in right-hand duct flows through modesty panel duct to inner side of vertical duct at No. 1 post. Air in vertical ducts is forced into ducts in bottom of package racks. Openings in package rack ducts distribute conditioned air evenly throughout coach.

RECIRCULATING AIR

Recirculating air duct is located under aisle floor and extends forward from rear cross seat to front baggage compartment. Recirculating air enters duct through grilles in seat pedestals and in outer sides of rear cross seat riser. Air in duct flows forward into evaporator compartment in front baggage compartment. Recirculating air is conditioned by flowing through cooling evaporator (if used) then through heating radiator and into main blowers.

FRESH AIR

Fresh air enters system through a grilled opening on each side of roof above No. 1 window. Fresh air blowers, in front edge of package racks, force air into fresh air ducts. Fresh air ducts (fig. 13) are located in outer side of vertical ducts at No. 1 post. Fresh air flows downward then inward in transverse ducts under floor, and into longitudinal ducts. Longitudinal ducts convey fresh air rearward into evaporator compartment where fresh and recirculated air is mixed.

Fresh air entering system displaces an equal amount of air from inside of coach. This air is exhausted through various small openings such as around entrance and emergency door seals, etc. Entry of fresh air slightly pressurizes interior of coach, effectively preventing entry of engine fumes, cold or hot air, etc. Volume of fresh air entering coach is approximately 35% of total volume of air circulated by main blowers.

DEFROSTING

Extensions of vertical air ducts at No. 1 posts, convey conditioned air to windshield, discharging through slots in windshield header.

For additional defrosting, a motor driven fan is mounted in each conditioned air duct at No. 1 post. Controlled by "DEFR." switch on switch panel, fans blow conditioned air to windshield through grilles in forward face of vertical air duct. Refer to wiring diagrams in Wiring (Sec. 7A of this manual) for defroster electrical circuits.

HEATING

Heating radiator, located in front baggage compartment at front bulkhead, warms air circulating through coach. Radiator is supplied with hot water from coach engine, conveyed by pipes running through recirculating air duct.

Degree of heat imparted to air is automatically controlled by heating radiator thermostat in supply pipe at heating radiator. A coiled tube, connected to thermostat bellows valve, is mounted in recirculating air duct. Coiled tube is sensitive to temperature changes in recirculated air. Coiled tube directly actuates bellows valve, to modulate flow of water to heating radiator.

Heating system can be shut off as desired. Gate valve for this purpose, is located in heater supply line in engine compartment.

HEATING SYSTEM MAINTENANCE

Flush heater system thoroughly at semi-annual intervals. Refer to Cooling System (Sec. 6A of this manual) for information on cleaners and inhibitors.

Inspect heater pipe connections periodically and replace or tighten as necessary to prevent leaks.

Heating radiator thermostat requires no maintenance, or adjustment. Do not change dial setting of thermostat. This should remain as set at factory for best results.

ELECTRICAL SYSTEM

Standard wiring diagram is shown in figure 11. Special wiring diagram, meeting New York state requirements, is shown in figure 12. Special wiring is similar to standard, but provides for constant operation of fresh air blowers whenever coach engine operates at speed faster than idling. Defroster wiring is shown on general wiring diagram in Wiring (Sec. 7A of this manual).

OPERATION

Movement of "Control" switch to "Run" position energizes circuit to "Turn-on" thermostat, in coach (fig. 13). Thermostat contacts close on rising temperature of 76°F, completing circuit and illuminating "Air Conditioning Turn-on" telltale.

Positioning blower switch in either "Ventilation" or "Cooling" positions energizes coil of main blower magnetic switch, closing contacts. Current from battery flows through closed contacts to operate main blowers. Current flow through main blower magnetic switch also flows through normally closed contacts of fresh air blower magnetic switch to operate fresh air blowers.

On standard system (fig. 11), with main blower switch in "Ventilation" position only, circuit to "Fresh Air Blower Cutout" switch is energized. Pulling out "Fresh Air Blower Cutout" switch momentarily completes circuit, energizing coil of fresh air blower magnetic switch. Energized magnetic switch breaks current flow to fresh air blowers and blowers cease to operate. Although initial flow of current to fresh air blower magnetic switch is momentary, switch remains energized by current flow through "A1" and "A2" contacts. Fresh air blower magnetic switch remains energized until main blower switch is moved to "Off" or "Cooling" positions.

On special system (fig. 12), blower cutout switch is omitted. Instead, coil of fresh air blower magnetic switch is connected to armature circuit of coach generator. Whenever coach generator is charging, coil of fresh air blower magnetic switch is energized. Energized switch completes circuit from battery to fresh air blowers. Consequently, regardless of position of main blower switch, fresh air blowers operate whenever coach generator is charging.

When cooling (air conditioning) unit is installed, ground jumper connection to coil terminal of main blower magnetic switch should be removed. Main blower magnetic switch is then grounded through

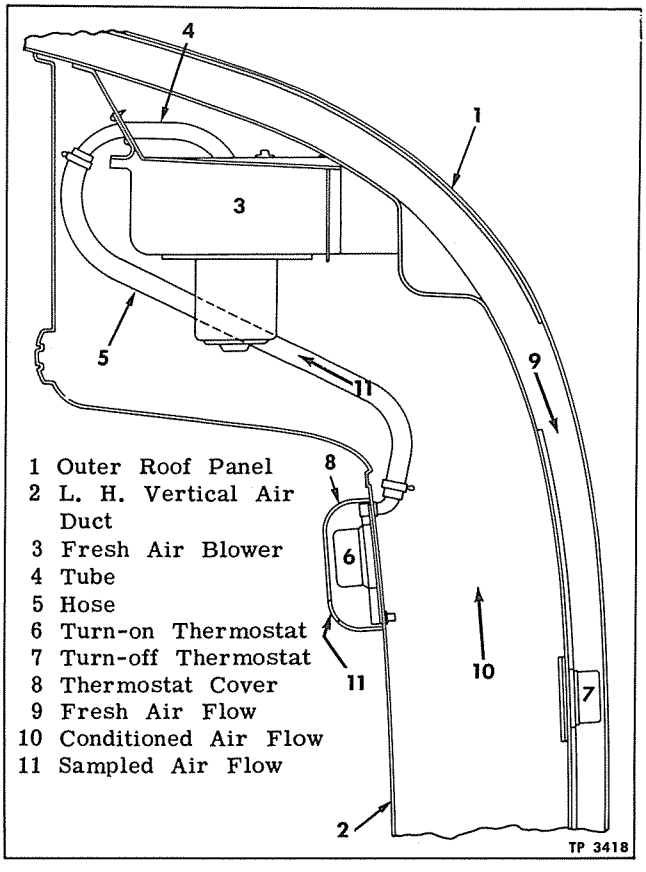

Figure 13—Thermostat Installation

"Arm" terminal on generator regulator of air conditioning engine. Main blower magnetic switch then operates as described earlier except when air conditioning engine is running.

As air conditioning engine starts and gains speed, positive (+) or ground potential of regulator "Arm" terminal reverses and becomes negative (-) or "hot." Main blower magnetic switch is de-energized, as a consequence, and contacts open. However, since air conditioning generator is now charging, circuit from "Bat." terminal of regulator supplies current for operation of main and fresh air blowers. On special system, however, if coach generator is charging, current for fresh air blowers is obtained from battery.

ELECTRICAL CHECK CHARTS

Charts on pages 84 and 85, are for use in conjunction with wiring diagrams, figures 11 and 12, respectively.

Charts show unit operation and points in circuits at which current indication should be obtained, with switches positioned as shown at top of each column. Blanks indicate "dead" circuit, or non-functioning unit.

BODY

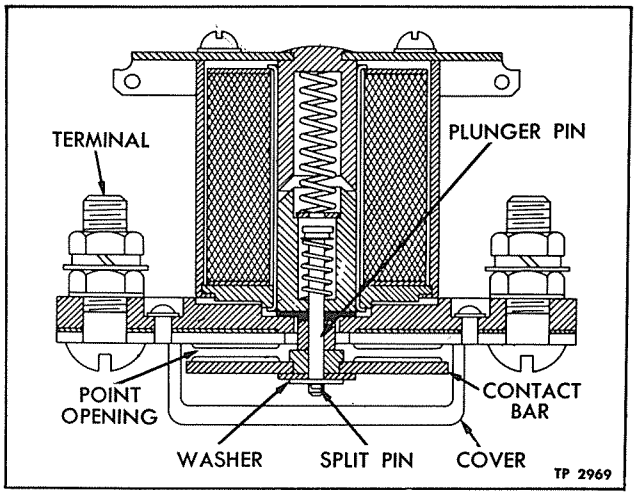

Figure 14—Main Blower Magnetic Switch

Reference to chart and wiring diagram will aid in isolating source of trouble, when checking with low-candlepower test light or voltmeter. Failure to obtain current at all points listed in each column indicates defective unit or circuit. Most probable cause of trouble can then usually be determined by tracing current flow on wiring diagram through defective circuit or unit.

THERMOSTATS

Turn-off and turn-on thermostats are mounted as shown in figure 13. Function of thermostats is to operate "Turn-off" and "Turn-on" tell-tales on driver's switch panel. Thermostats are similar except for settings and terminals to which wires are connected.

Purpose of hose and tube is to provide a constant flow of air to turn-on thermostat. Suction at intake of fresh air blower causes a small quantity of air from coach to flow past thermostat. Thermostat constantly samples air in coach and reacts rapidly to temperature changes.

Maintenance

Thermostats require no maintenance and should not be disturbed unless they fail to function. Turn-on thermostat points close on rising temperature of 76°F. Turn-off thermostat points close at falling temperature at 55°F.

Thermostat dials are locked with set screws. Do not change dial settings, except for test. After tests are completed, turn dial to original setting and lock in place with set screw.

When testing, use an accurate thermometer placed close to thermostat to check temperature. Allow sufficient time for both thermostat and thermometer to reach room temperature. Avoid touching thermostat and thermometer unnecessarily since body heat will affect operating point of thermostat.

Replace thermostat if tests disclose improper operation. Thermostat is non-reparable in the field and, except for dial, is non-adjustable. Sealed silver contacts require no cleaning, and should operate indefinitely.

CAUTION: Any attempt to adjust or repair thermostat will undoubtedly destroy calibration. Once this occurs, thermostat must be returned to factory for repairs.

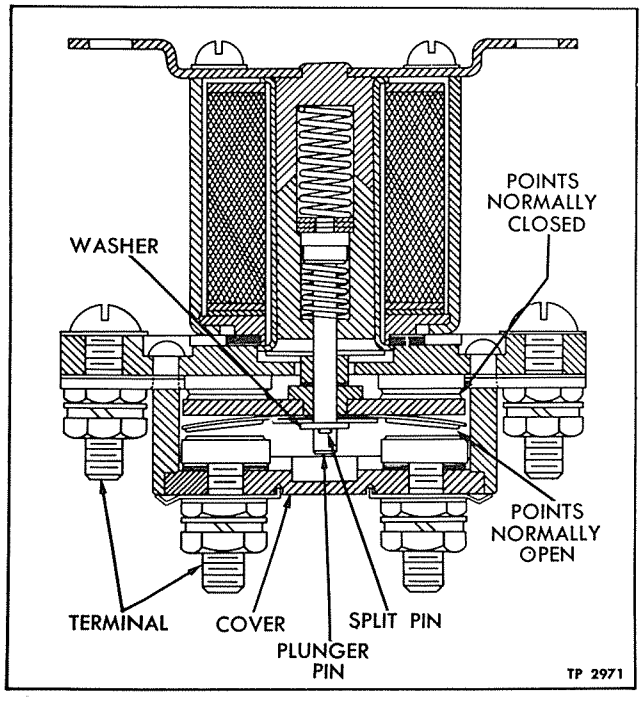

Figure 15—Fresh Air Blower Magnetic Switch

MAIN BLOWER MAGNETIC SWITCH

Magnetic switch is mounted in air conditioning compartment, accessible from left side of coach. Switch acts as relay for main blower motors.

Inspection and Cleaning

Before removing switch, make sure "Ventilation" switch is in "Off" position. Mark wires and terminals to assure proper connection at installation.

Remove cover to inspect points, but do not clean points unless necessary. Points are silver and tend to oxidize (blacken) rapidly. However, oxide coating does not impair efficiency. Consequently, clean points only if pitted or burned, and not if points are only blackened.

CAUTION: Do not use point file or emery paper on points. Use only fine crocus cloth or, preferably, toilet tissue, and apply only slight pressure.

Point Replacement

If points are badly burned, contact bar may be replaced (fig. 14). Remove split pin, washer, and contact bar from plunger pin. Position new contact bar on plunger pin, then install washer and split pin. Make sure plunger and contacts operate properly before installing switch cover.

MAIN BLOWERS

Blowers are mounted on front longitudinal members, forward of baggage compartment front bulkhead. Blower motors are flange-mounted on outside of longitudinal members. Blower wheels and housings are mounted in duct inside longitudinal members.

Maintenance

Blower motors require no periodic lubrication or maintenance. Motors, however, should be removed and overhauled annually. Overhaul should be in accord with established electrical practice, concerning such items as brush replacement, commutator turning, and mica undercutting.

After overhaul and prior to installation, motor must be waterproofed. Apply coating to entire motor, except mounting surface of flange and motor shaft. Use a good waterproofing compound, preferably rubber-type such as applied by motor manufacturer.

Blower wheels must be removed from motor shafts before motors can be removed from coach. Blower wheels are accessible from underneath vehicle after removal of blower compartment cover. When installing cover, seal with a caulking compound such as listed at end of this section.

FRESH AIR BLOWER MAGNETIC SWITCH

Magnetic switch (fig. 15) is mounted on buzzer panel, located forward of instrument panel. On standard wiring system, switch functions to break circuit to blowers when their operation is not desired. On special (N.Y.) system, switch is connected to coach engine generator, and turns on fresh air blowers whenever generator is charging.

Inspection and Cleaning

Before removing switch, make sure "Ventilation" switch is in "Off" position, and remove 20 amp. fuse on buzzer panel. Mark wires and terminals to assure proper connection at installation.

Remove cover to inspect points, but do not clean points unless necessary. Points are of silver and tend to oxidize (blacken) rapidly. However, oxide coating does not impair efficiency. Consequently, clean points only if pitted or burned, and not if points are only blackened.

CAUTION: Do not use point file or emery paper on points. Use only fine crocus cloth or, preferably, toilet tissue, and apply very slight pressure.

Point Replacement

If points are badly burned, contact bar may be replaced (fig. 15). Remove split pin, washer, and contact bar from plunger pin. Position new contact bar on plunger pin, then install washer and split pin. Make sure plunger and contacts operate properly before installing switch cover.

FRESH AIR BLOWERS

Blowers are mounted in duct above forward end of package racks. Blower motors are flange mounted to blower housing. Motors are accessible after removal of covers in underside of package racks. Blower wheels, mounted on motor shafts, are removed with motor from housing.

Maintenance

Blower motors require no periodic lubrication or maintenance. Motors, however, should be removed and overhauled annually. Brush replacement, commutator turning, and mica undercutting should be done in accord with established electrical practice.

SPECIAL MATERIAL

GMC Sealing and Caulking Compound is recommended for use as a sealer in general body maintenance and repair. This compound may be used whenever it is necessary to exclude water, dust, cold, and air. It may also be used for bedding glass and gaskets, as seal for water hose, and as insulation for battery and electrical terminals.

GMC Sealing and Caulking Compound will not become brittle, hard, shrink, crack, or "bleed" through any color. By reason of effecting a soft cushion between points of contact it acts as a most efficient anti-squeak. The compound is supplied in various container sizes, as follows:

Part No.	Container Size
2211921	1 pint can
2211922	1 quart can
2211923	1 gallon can
2211924	5 gallon can

BODY

HEATING SYSTEM OPERATION ELECTRICAL CHECK CHART

(Standard System Fig. 11)

SWITCH POSITION: Engine Control / Fresh Air Cutout / Ventilation	Off Off	Run Off	Run Vent.	Run * Vent.	Run Cooling	Run Cooling
Air Cooling System						Operating
UNIT OPERATION:						
Main Blower Magnetic Switch			Energized	Energized	Energized	
L. S. Main Blower			Operating	Operating	Operating	Operating
R. S. Main Blower			Operating	Operating	Operating	Operating
Fresh Air Blower Magnetic Switch				Energized		
L. S. Fresh Air Blower			Operating		Operating	Operating
R. S. Fresh Air Blower			Operating		Operating	Operating
Turn-on Thermo.						
(temp. above 76°F)	Closed	Closed	Closed	Closed	Closed	Closed
(temp. below 76°F)	Open	Open	Open	Open	Open	Open
Turn-on Tell-tale						
(temp. above 76°F)		On	On	On	On	On
(temp. below 76°F)						
Turn-off Thermo.						
(temp. above 55°F)	Open	Open	Open	Open	Open	Open
(temp. below 55°F)	Closed	Closed	Closed	Closed	Closed	Closed
Turn-off Tell-tale						
(temp. above 55°F)						
(temp. below 55°F)					On	On
FUSES:						
No. 4 Inst. Panel		Hot	Hot	Hot	Hot	Hot
No. 27 Inst. Panel			Hot		Hot	Hot
No. 28 Inst. Panel			Hot		Hot	Hot
Buzzer Panel	Hot	Hot	Hot	Hot	Hot	Hot
JUNCTIONS:						
No. 9 Body			Hot		Hot	Hot
No. 11 Body			Hot		Hot	Hot
No. 24 Inst. Panel			Hot	Hot	Hot	Hot
No. 25 Inst. Panel				Hot		
No. 31 Inst. Panel	Hot	Hot	Hot	Hot	Hot	Hot
No. 32 Inst. Panel					Hot	Hot
No. 33 Inst. Panel			Hot	Hot	Hot	Hot

* After switch is closed.

Refer to page 81 for instructions.

ELECTRICAL CHECK CHART
HEATING SYSTEM OPERATION
(Special N.Y. System Fig. 12)

SWITCH POSITION: Engine Control / Ventilation / Generator Operation	Off Off	Run Off Disch'g.	Run Off Charge	Run Vent. Disch'g.	Run Vent. Charge	Run Cooling Disch'g.	Run Cooling Charge
Air Cooling System							Operating
UNIT OPERATION:							
Main Blower Magnetic Switch				Energized	Energized	Energized	
L.S. Main Blower				Operating	Operating	Operating	Operating
R.S. Main Blower				Operating	Operating	Operating	Operating
Fresh Air Blower Magnetic Switch			Energized		Energized		Energized
L.S. Fresh Air Blower			Operating	Operating	Operating	Operating	Operating
R.S. Fresh Air Blower			Operating	Operating	Operating	Operating	Operating
Turn-on Thermo, (temp. above 76°F)	Closed	Closed	Closed	Closed	Closed	Closed	Closed
(temp. below 76°F)	Open	Open	Open	Open	Open	Open	Open
Turn-on Tell-tale (temp. above 76°F)		On	On	On	On	On	On
(temp. below 76°F)							
Turn-off Thermo, (temp. above 55°F)	Open	Open	Open	Open	Open	Open	Open
(temp. below 55°F)	Closed	Closed	Closed	Closed	Closed	Closed	Closed
Turn-off Tell-tale (temp. above 55°F)							
(temp. below 55°F)						On	On
FUSES:							
No. 4 Inst. Panel		Hot	Hot	Hot	Hot	Hot	Hot
No. 27 Inst. Panel			Hot	Hot	Hot	Hot	Hot
No. 28 Inst. Panel			Hot	Hot	Hot	Hot	Hot
Buzzer Panel	Hot	Hot	Hot	Hot	Hot	Hot	Hot
JUNCTIONS:							
No. 9 Body			Hot	Hot	Hot	Hot	Hot
No. 11 Body			Hot	Hot	Hot	Hot	Hot
No. 4 Inst. Panel			Hot		Hot		Hot
No. 24 Inst. Panel				Hot	Hot	Hot	Hot
No. 31 Inst. Panel	Hot	Hot	Hot	Hot	Hot	Hot	Hot
No. 32 Inst. Panel						Hot	Hot
No. 33 Inst. Panel				Hot	Hot	Hot	Hot

Refer to page 81 for instructions.

BODY

SPECIFICATIONS

PASSENGER BUZZER
- Make ..... Farady
- Model 22983

TURN-ON THERMOSTAT
- Make ..... Spencer
- Type RT2C-30
- Terminals Used 1-2
- Dial Locked at ..... 75°F.

TURN-OFF THERMOSTAT
- Make ..... Spencer
- Type RT2-30
- Terminals Used 1-3
- Dial Locked at ..... 56°F.

MAIN BLOWER MAGNETIC SWITCH
- Make ..... Cutler-Hammer
- Type ..... SPST, Continuous Duty
- Volts 12.0
- Current ..... 0.046 Amp.

MAIN BLOWER MOTOR
- Make ..... Delco
- Volts D.C. 13.0
- H.P. 0.15
- R.P.M. 1125

FRESH AIR BLOWER MAGNETIC SWITCH
- Make ..... Cutler-Hammer
- Type ..... SPDT, Continuous Duty
- Volts 12.0
- Current ..... 0.046 Amp.

FRESH AIR BLOWER MOTOR
- Make ..... Delco
- Volts, D.C. 13.0
- Current ..... 4.5 Amp.
- H.P. 1/25
- R.P.M. 1650

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however, are not supplied by GMC Truck & Coach Division. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

Number	Name
CS-1154-A	Seal and Insert Installer consisting of:
CS-1154-1	Handle (for eye)
CS-1154-4	Collet (for eye)
CS-1154-3	7/16" Eye
CS-1154-2	Handle (for hook)
CS-1154-9	Hook
CS-1154-12	Special Hook (for rear window)

Vendor	Address
Curtiss & Smith Mfg. Co.	Pottstown, Pennsylvania

Air Brakes

Contents of This Section

Related Subjects in Other Sections

AIR SYSTEM

Air Line Diagram (fig. 1) shows air lines installation and approximate location of air pressure controls and air-operated devices. The solid black lines in air line diagram are "hot" lines, that is, they contain full air system pressure at all times when air pressure is above 65 pounds. Open lines contain air pressure only when delivering pressure to their respective units.

The air system may be classed as two interconnected systems, the Main Air System and the Auxiliary Air System. The pressure regulating valve (fig. 1) is the dividing point between the main air system and the auxiliary air system. This valve prevents air pressure from entering the auxiliary air system until the pressure in the main air system reaches 65 pounds. This provides rapid build-up of pressure in the main air system for operation of vehicle brakes.

The pressure regulating valve also prevents lowering the pressure in the main air system below 65 pounds by operating the units which are supplied by the auxiliary air system or by leakage in the auxiliary air system lines. However, in the event the pressure in the main air system falls below 65 pounds, pressure in the auxiliary air system returns to the main air system via the one-way check valve (fig. 1).

MAIN AIR SYSTEM

The primary function of the main air system is to supply and control air pressure for operation of the vehicle braking system. This system includes the air compressor, Nos. 1, 2, and 3 air tanks, and interconnected units. For information covering the air compressor and governor, refer to Air Compressor and Governor (Sec. 4C of this manual).

AUXILIARY AIR SYSTEM

Air pressure for the auxiliary air system is stored in No. 4 air tank. This system supplies air pressure for operation of air pressure guage, windshield wipers, air horn, radiator shutter controls, air compressor governor, and radio aerial motor (when used).

MISCELLANEOUS AIR SYSTEM EQUIPMENT

Only those units whose functions are directly related to the vehicle braking system are covered in this section. For information on other air system equipment, refer to table on next page.

AIR BRAKES

Item	Section	Page
*Low Air Pressure Indicator	7A	141
Stop Light Switch	7G	185
Radiator Shutter Thermostat, Air Filter and Air Chamber	6B	135
Windshield Wiper Valves and Wipers	3B	63
Air Horn Valve and Air Horn	3B	63

*NOTE: Low air pressure indicator operates in conjunction with Moto-gard and Tell-tale Alarm System. Operation of this system is explained in Operation (Sec. O of this manual).

MAINTENANCE

Procedures for testing, adjusting, and overhauling the various items included in the air brake system are described under individual headings later in this section. It is imperative that all air tanks and air compressor discharge muffler be drained daily to eliminate any condensation which has collected in the tanks.

In cold weather, particular attention should be given to draining the air system. Where necessary to protect the system as in cases of extreme cold weather, an alcohol evaporator should be used to introduce alcohol vapor into the air system.

Detailed specifications are tabulated at end of this section, and a trouble shooting table is provided in Trouble Shooting (Sec. 21 of this manual) to facilitate analysis and correction of improper operation.

BRAKE ADJUSTMENT

Service brake adjustment for normal lining wear is made by turning slack adjuster worm shaft (fig. 2). Slack adjuster worm shaft rotates camshaft, changing cam position in relation to brake chamber push rod, thus adjusting clearance between shoes and brake drum. Brake chamber push rod travel should be checked after every 1,000 miles of operation to determine whether adjustment is necessary. While maximum travel is permissible, it is advisable to maintain travel as close to minimum as possible, both for braking efficiency and economy in air consumption. Brake linings should be replaced when they become worn to a thickness of 5/16" at center of shoe. The adjustment is made as follows (fig.2):

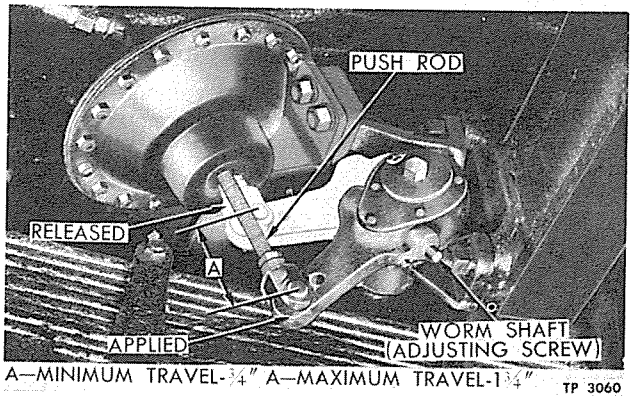

Figure 2—Brake Adjustment (Typical)

1. Always check wheel bearing adjustment before attempting to adjust brakes. Refer to Hubs and Bearings (Sec. 19A of this manual).
2. Measure push rod travel from fully released to fully applied positions.
3. If travel is appreciably greater than minimum shown in figure 2, turn slack adjuster worm shaft until travel is reduced to minimum.
4. Be sure wheel turns freely with no brake drag when brakes are fully released. It is not advisable to reduce the push rod travel below the minimum shown in figure 2.

AIR TANKS

Air tanks are connected in air system as shown in figure 1. Air tanks are mounted at lowest points in system to permit drainage of system into tanks.

The purpose of the air tanks is to provide a place to store compressed air so there will always be an ample supply available for immediate use for brake operation. They also provide storage for sufficient compressed air to permit several brake applications after the engine stops.

Another purpose of the tanks is to provide a place where the air, heated during compression, may cool and the oil and water vapors condense. This condensation must be drained from tanks daily. Drain cocks are provided at the bottom of each tank.

Check all tank mounting bolts for looseness at regular intervals and tighten if necessary. Air tanks may be cleaned inside using steam or hot water. Inspect tanks inside and out for corrosion. The interior may be inspected with the aid of a small flashlight. If corrosion or other damage has weakened the tank, it must be replaced.

SAFETY VALVE

A safety valve, shown in figure 3, is installed between the No. 1 and No. 2 air tank (fig. 1) to eliminate the possibility of air pressure building up in the system beyond a predetermined safe maximum (150 lbs).

OPERATION

When reservoir pressure is built up to exceed 150 pounds, force of air pressure forces ball (4)

off of seat (B), permitting air pressure in excess of 150 pounds to escape through exhaust port (A) to atmosphere. After pressure bleeds down, spring (3) forces ball (4) back on seat (B).

MAINTENANCE

Check safety valve periodically for leakage, using soap suds at exhaust port. Leakage should not exceed a 3-inch bubble in 3 seconds. Once a year, valve should be dismantled, thoroughly cleaned, and reset to blow off at 150 pounds.

ADJUSTMENT (Fig. 3)

Set safety valve in following manner:

1. Loosen lock nut (2).
2. Adjust set pressure by turning adjusting nut (1). Turn nut clockwise to increase pressure, or counterclockwise to decrease pressure.
3. Tighten lock nut (2).

AIR LINES

Metal tubing and flexible hose are used to connect the various units of the air brake system. Service instructions for both types follows.

METAL TUBING

Metal tubing is used to connect the air brake devices where it is not necessary to use flexible hose. Metal lines are of annealed copper tubing with three-piece compression type fittings. Flared type fittings should never be used in air brake systems. Connections should be tested at least every 5,000 miles and tightened or replaced if necessary. When replacing metal tubing, it is important that replacement tubing be of the same size as the old tubing to provide safe and efficient brake operation.

FLEXIBLE HOSE

Flexible hose is used at each brake chamber and at other points where it is impossible to use metal tubing due to constant flexing during vehicle operation. Hose connections should be tested at least every 5,000 miles and tightened or replaced if necessary. Any hose which is chafed, worn, or kinked should be replaced.

SERVICEABILITY TESTS

1. Operating Test

If any of the symptoms given in Trouble Shooting (Sec. 21 of this manual) indicate that a metal tube or flexible hose is restricted, remove tubing or hose and blow through it in both directions to make sure the passage is clear. Inspect tubing and hose for partial restriction such as would be caused by dents or kings. If such a condition is found, the tubing or hose should be replaced.

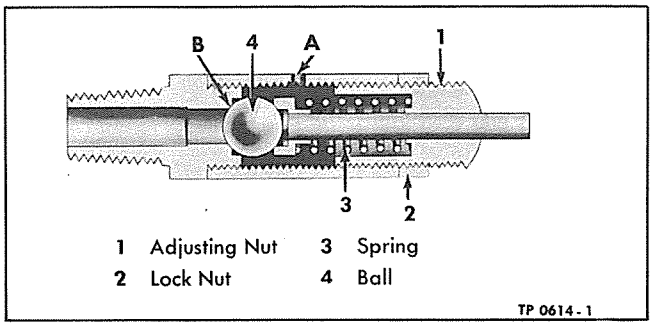

Figure 3—Safety Valve

2. Leakage Test

With air brake system fully charged and brakes applied, coat all tubing and hose connections with soap suds to check for leakage. No leakage is permissible. Leakage is sometimes corrected by tightening the connection. If this fails to correct leakage, new fittings, metal tubing, or flexible hose must be used.

DISCHARGE LINE CHECK VALVE

One-way check valve (fig. 4) is installed in air compressor discharge line as shown in figure 1. This valve performs no function in the air system except as a safety device. In the event of leakage or breakage in the air compressor to muffler coil, check valve prevents loss of air pressure from air system. Check valve should be removed, disassembled, and cleaned at regular intervals. When installing valve, make sure it is installed to permit air flow in direction of arrow on valve body.

AIR PRESSURE GAUGE

The air pressure gauge in the instrument panel is connected into the air lines as shown in figure 1. Since the gauge receives its air pressure

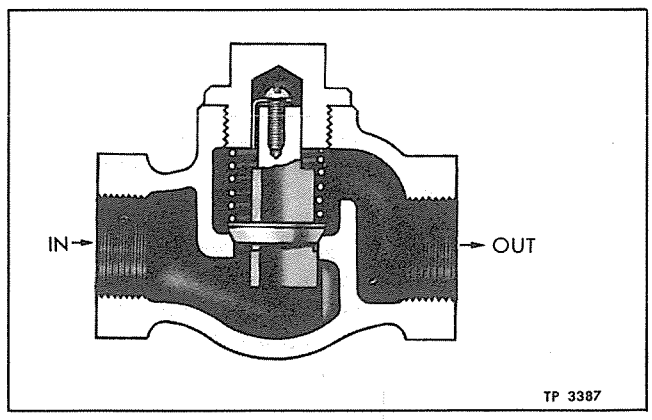

Figure 4—Discharge Line Check Valve

AIR BRAKES

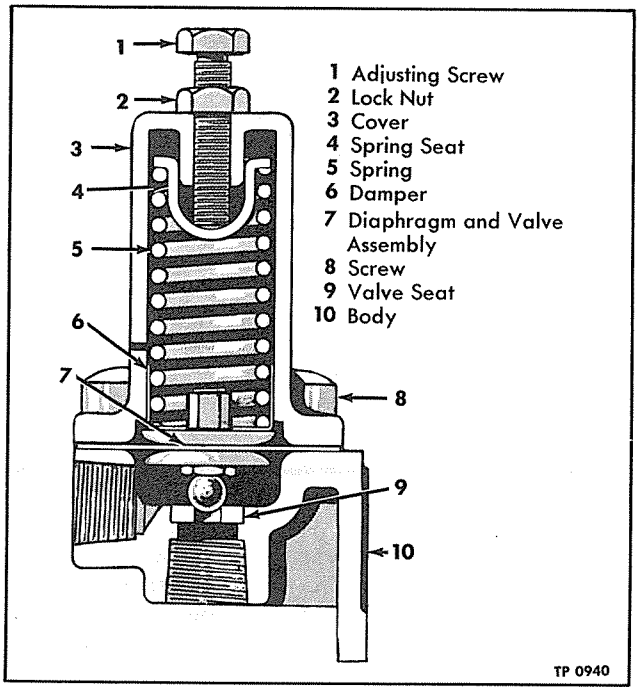

Figure 5—Pressure Regulating Valve

from the No. 4 air tank, it will register no increase in pressure until the pressure in the main air brake system is built up above 65 pounds, opening pressure regulating valve and admitting air to No. 4 tank; however the gauge will register a decrease in pressure, regardless of pressure in system, since the pressure in the auxiliary system returns to the main air brake system as the pressure is reduced in the latter system.

The vehicle should never be put in motion until pressure reaches 70-75 pounds. If, while vehicle is in motion, pressure drops below 75 pounds, stop vehicle immediately and determine cause of pressure loss. Check gauge regularly with an accurate test gauge. Replace with a recalibrated unit if reading varies 4 pounds.

PRESSURE REGULATING VALVE

Pressure regulating valve (fig. 5) is connected in air lines as shown in figure 1. The unit consists essentially of a valve, diaphragm, and spring, enclosed by a valve body and cover. Adjustment is made by means of the adjusting screw in the cover.

The pressure regulating valve serves two purposes in the air system of vehicles covered by this manual. One purpose is to prevent air pressure from entering the auxiliary air system until pressure in the main air brake system reaches 65 pounds. This provides a rapid build-up of pressure in the main air brake system for operation of vehicle brakes. When air pressure in main air brake system reaches 65 pounds, the pressure regulating valve admits pressure into the auxiliary system (No. 4 tank) for operation of windshield wipers, air horn, air pressure gauge, radio aerial motor (when used), radiator shutter controls, and air compressor governor. The second purpose of the pressure regulating valve is to prevent lowering the pressure in the main air system below 65 pounds by operating the units which are supplied by the auxiliary air system.

OPERATION (Key Numbers Refer to Fig. 5)

The pressure regulating valve shown in figure 5 is the closed position; this indicates that pressure in the main air system, which connects to side opening in the valve, is below 65 pounds and the spring (5) above the diaphragm (7) is holding the valve against its seat (9). When pressure in main air system reaches 65 pounds, the pressure in the cavity below the diaphragm overcomes the spring tension above the diaphragm and lifts the diaphragm up. This raises the valve off its seat and permits air pressure to pass out through the opening in the bottom of the valve and into the air lines leading to the No. 4 air tank and to the units which are supplied by the auxiliary air system. When the pressure in the air brake system falls below 65 pounds, the spring closes the valve and prevents air pressure from entering the auxiliary air system until the pressure in the air brake system is again built up.

SERVICEABILITY TESTS

1. Operating Test

Exhaust air pressure from system and install a test gauge in air brake system, preferably in the air line leading from air tank to the pressure regulating valve. Disconnect one of the air lines from the bottom of the pressure regulating valve. Build up pressure in system and note at what pressure the valve permits air to pass to atmosphere. If pressure varies 5 pounds from the original setting (65 lbs.), the valve requires adjustment.

2. Leakage Test

With air line disconnected from bottom of pressure regulating valve and pressure in air brake system below the valve setting (65 lbs.), coat the bottom opening of valve with soap suds. Leakage is caused by dirt on the valve seat or by an excessively worn valve.

ADJUSTING SET PRESSURE (Fig. 5)

The pressure at which the valve is unseated is controlled by the adjusting screw (1). Setting may be increased or decreased by turning screw.

1. Back off lock nut (2).
2. To increase pressure turn screw (1) clock-

wise; to decrease pressure, turn screw counterclockwise.

3. Tighten lock nut (2) when correct adjustment is obtained.

REPLACEMENT

1. Removal. Exhaust air from system and disconnect air lines. Remove mounting bolts and remove unit from vehicle.

2. Installation. Position unit and install mounting bolts. Connect air lines and test valve as previously directed under "Serviceability Tests."

DISASSEMBLY (Fig. 5)

Remove four screws (8) attaching cover (3) to body (10) and remove cover. Remove spring (5), spring seat (4), and damper (6) from cover and lift diaphragm and valve assembly (7) off body.

INSPECTION (Fig. 5)

Clean all parts thoroughly, using a suitable cleaning fluid. Examine diaphragm for cracks or wear. If either the valve or diaphragm are worn or damaged, a new diaphragm and valve assembly should be installed. Inspect valve seat in body and valve seat assembly.

ASSEMBLY (Fig. 5)

Place diaphragm and valve assembly (7) on body, with valve seated in valve seat in body. Install spring seat (4), spring (5), and damper (6) in cover (3) and position cover on body (10). Install four screws (8) through cover and diaphragm into body and tighten firmly. Adjust set pressure as previously directed under "Adjusting Set Pressure."

AUXILIARY AIR SYSTEM CHECK VALVE

Check valve (fig. 6) is connected in air lines at pressure regulating valve as shown in figure 1. This valve is a "one-way" valve; that is, air pressure can flow through it only in one direction (see arrow in figure 1). Check valve prevents air pressure from flowing into the auxiliary air system (No. 4 tank) without passing through pressure regulating valve; however, it permits air pressure in auxiliary air system to return to main air brake system when the pressure in the main air brake system is reduced. Whenever check valve is removed, it is essential that it be reinstalled to permit air flow in direction indicated by arrow in figure 6.

BRAKE APPLICATION VALVE

Brake application valve (fig. 7) is a preloaded treadle type D-1 brake valve mounted underneath

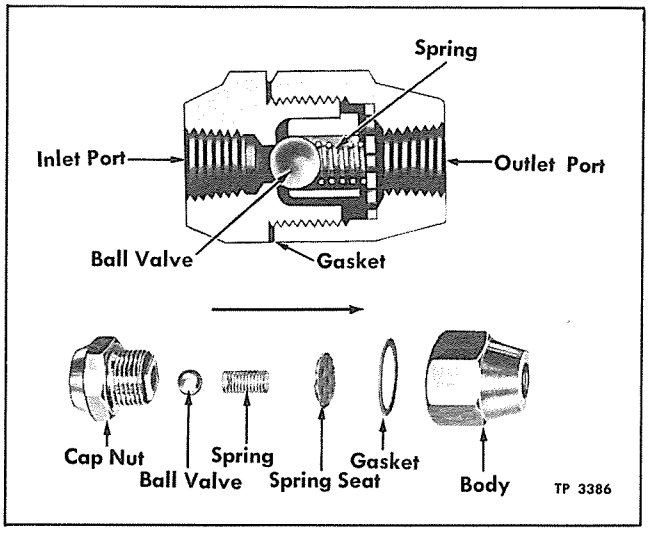

Figure 6—Auxiliary Air System Check Valve

the toeboard on the left side of the vehicle. Brake treadle is mounted on top of toeboard with the treadle roller contacting the valve cap. Application valve is connected into air lines as shown in figure 1.

OPERATION (Fig. 7)

1. Application

As the driver depresses the brake treadle, pressure is transmitted through the treadle roller, valve cap, and spring cage to the pressure regulating spring and diaphragm. As the diaphragm and plunger moves downward, the exhaust valve seat contacts the exhaust valve. Continued downward movement of diaphragm and plunger pushes the inlet valve off its seat. This permits air pressure to flow through the inlet valve and out the ports to the quick release valves and stop light switch, applying the brakes and lighting the stop lights.

The treadle stop screw on the toeboard prevents the treadle being depressed beyond the graduated pressure range. Fully depressing the treadle without this stop would cause the spring cage to bottom on the spring seat and hold the inlet valve off its seat, delivering full reservoir pressure to the brakes.

2. Holding

When the air pressure being delivered to the quick release valves from the cavity below the diaphragm balances the mechanical force on top of the diaphragm, the diaphragm lifts permitting the inlet valve to close, but not enough to open the exhaust valve. This prevents additional air pressure being admitted to the quick release valves, and at the same time prevents air pressure already delivered to these units from es-

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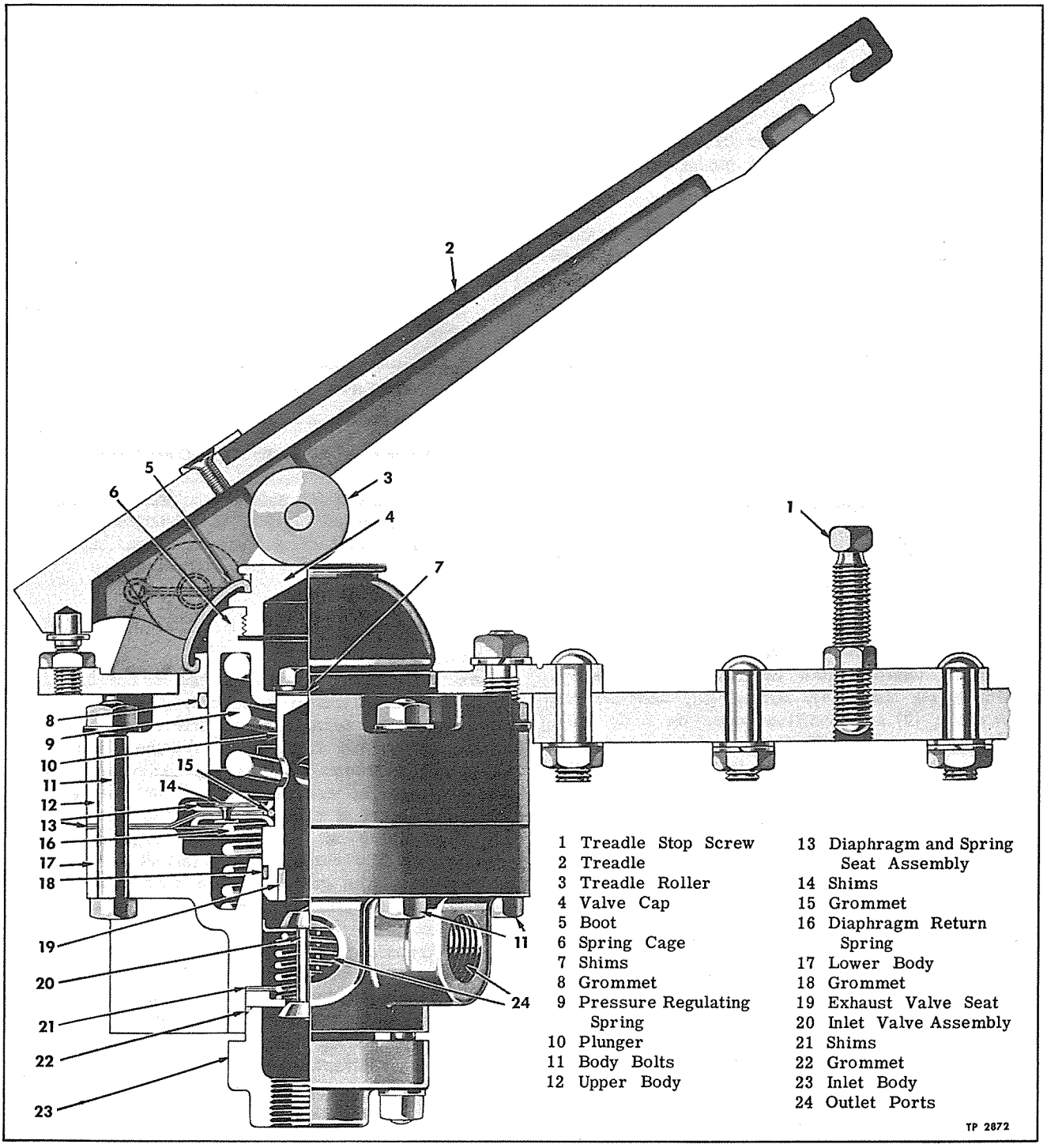

Figure 7—Brake Application Valve

caping through the exhaust valve and exhaust port, and brakes are held in applied position. Should the driver depress the treadle still further exerting additional force on top of the diaphragm, a corresponding increase in air pressure being delivered to the quick release valves results.

3. Partial Release

If the driver permits the treadle to partially return toward its released position, reducing the mechanical force on top of the diaphragm, the air pressure below the diaphragm overcomes the mechanical force on top of it. When this occurs

the diaphragm lifts, closing the inlet valve and opening the exhaust valve, permitting air pressure in cavity below diaphragm to escape through the exhaust port until the pressure below the diaphragm again balances the mechanical force on top of it.

4. Release

When the driver permits the brake treadle to return to its fully released position, the exhaust valve remains open and all pressure in the cavity below the diaphragm and in the air lines connected to this cavity is exhausted and the brakes return to released position.

APPLICATION VALVE SERVICEABILITY TESTS

1. Operating Tests

a. Check the delivery pressure of the valve, using an accurate test gauge. The gauge should be connected to test fitting (fig. 1) located in tool compartment in left front corner of vehicle With the treadle fully depressed against the treadle stop on the toeboard, test gauge should show 65 pounds pressure. Stop screw (fig. 7) should be adjusted to stop treadle at point at which this pressure is obtained.

b. Depress the brake treadle to several positions between fully released and fully applied position and make sure the delivered pressure registered by the gauge varies in accordance with degree brake treadle is depressed.

2. Leakage Tests

a. With treadle fully released, coat the exhaust port with soap suds and check for leakage. Leakage in excess of a 3-inch soap bubble in 3 seconds is not permissible. Leakage evidenced by this test may be caused by inlet valve not seating properly.

b. With treadle fully depressed, coat the exhaust port with soap suds and check for leakage. Leakage in excess of a 3-inch soap bubble in 3 seconds is not permissible. Leakage evidenced by this test may be due to a leaking exhaust valve or by a leaking diaphragm.

APPLICATION VALVE REPLACEMENT

1. Removal

Exhaust air from system and disconnect air lines. Remove mounting stud nuts at top side of toeboard and remove unit from under vehicle.

2. Installation

Position unit in vehicle and install mounting stud nuts. Connect air lines, then start engine and build up air pressure in system. Test valve as previously directed under "Serviceability Tests."

APPLICATION VALVE DISASSEMBLY (Fig. 7)

1. Clean all dirt from exterior of unit prior to disassembly. Mark lower body in some manner that will identify location of the three long body bolts so outlet openings will be in correct position when valve is reassembled.

2. Pull rubber boot off from upper body and valve cap. Remove six bolts holding the upper and lower bodues together and separate bodies.

3. Push on valve cap to remove diaphragm assembly, pressure regulating spring, spring cage, plunger, and valve cap as an assembly from upper body. Remove diaphragm return spring from lower body. Remove grommets from grooves in upper body and plunger.

4. Remove nuts and lock washers from three studs securing inlet body to bottom of lower body. Remove inlet body, grommet, inlet valve assembly, and shims from lower body. Tie shims together and make sure the same ones are used at reassembly.

5. Do not disassemble the diaphragm, plunger, and spring cage assembly unless diaphragm or exhaust valve seat require replacement as indicated below under "Inspection."

INSPECTION

Thoroughly clean all parts in a suitable cleaning solvent, then inspect parts as outlined below:

Diaphragm, Spring Cage, and Plunger Assembly

1. Carefully inspect both diaphragms to make sure they are not cracked or deteriorated. If cracks or deterioration are evident, the diaphragm and spring seat assembly must be replaced as directed later under "Repair."

2. Inspect exhaust valve seat in lower end of plunger. If seat is tapered or rough, a new seat must be installed as directed later under "Repair."

3. Examine pressure regulating spring for damage. If damaged, the complete diaphragm and spring assembly must be replaced.

Upper Body

Check fit of spring cage in upper body. Spring cage must be a neat sliding fit in body. Examine diaphragm follower seat on bottom of upper body to make sure it is not damaged in such a way as to prevent perfect contact with the diaphragm follower. Inspect seat to make sure it is not nicked or damaged in any way to prevent perfect contact with the diaphragm. Check diaphragm seat radius for burrs or nicks. If any of the above conditions are evident, replace upper body.

Lower Body

Check fit of plunger in lower body. Plunger should be a neat sliding fit in body. Inspect diaphragm seat on top of body. If damaged in any

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way, replace body. Inspect diaphragm follower seat for excessive wear or damage. Replace body if worn excessively or damaged. Inspect small bleed hole leading from outlet port to diaphragm cavity to make sure it is not restricted.

Inlet and Exhaust Valve Assembly

Inspect inlet and exhaust valve assembly for broken spring and worn or damaged valves and seat. If damaged or worn excessively, replace the complete assembly.

REPAIR

The following procedure covers disassembly and assembly of the diaphragm, plunger, and spring cage assembly for replacement of the diaphragm or exhaust valve seat. It is imperative that the same shims removed from the assembly be reused at assembly.

Disassembly

1. Remove valve cap from spring cage, holding spring cage with a strap wrench or by using a special tool in steps at bottom of cage. Be sure not to score or damage the spring cage in any way.
2. Remove nut from top of plunger, holding the plunger with a rod inserted through the exhaust holes in the plunger. Remove flat washer and shims from top of plunger. Lift spring cage, pressure regulating spring, and shims off from plunger and diaphragm assembly. Be sure and keep shims intact for reuse at assembly.
3. Remove snap ring from plunger above diaphragm and lift diaphragm assembly.

Exhaust Valve Seat Replacement

Remove exhaust valve seat from lower end of plunger. Press new seat into plunger and ream to .525" plus or minus .002". Edge of seat must be sharp and true to form a perfect air seal.

Assembly

1. Place new grommet in diaphragm assembly, then place diaphragm assembly over small end of plunger with rivet heads down (toward large end of plunger). Install snap ring on plunger to hold diaphragm in place.
2. Place pressure regulating spring shims on diaphragm follower, being sure the same shims that were removed are used.
3. Place pressure regulating spring and spring cage on diaphragm and plunger. Compress pressure regulating spring and install shims, washer, and nut on top of plunger. Make sure the same shims that were removed are used. Tighten nut firmly and stake in place.
4. Thread valve cap into top of spring cage, tighten firmly, and stake in place.

APPLICATION VALVE ASSEMBLY (Fig. 7)

1. Place lower valve body on bench, bottom side up. Drop inlet valve shims into valve opening in bottom of body, being sure the same shims that were removed are used. Place inlet valve assembly in body, with the valve guide inserted in the bore in body.
2. Place new inlet valve body grommet in body on top of inlet valve seat, then install inlet valve body. Install lock washers and nuts on inlet valve body studs and tighten firmly.
3. Turn lower body over and place diaphragm return spring in body.
4. Install new grommets in grooves in plunger and upper body. Coat surface of spring cage and lower end of plunger lightly with petroleum jelly, then insert spring cage into upper body and align opening in diaphragm with opening in body.
5. Place upper body and diaphragm assembly on lower body with the lower end of the plunger inserted in bore in lower body and with the exhaust opening in diaphragm aligned with exhaust opening in lower body.
6. Align bolt holes in upper body, diaphragm, and lower body, and install six body bolts. Make sure the three long bolts are installed in the correct holes as marked on lower body prior to disassembly. Install lock washers and nuts on bolts and tighten firmly.
7. Install rubber boot on top of valve assembly, making sure edges of boot are properly seated in grooves in valve cap and upper body. Press down on valve cap several times to make sure the spring cage slides freely in upper body.

QUICK RELEASE VALVE

DESCRIPTION

Quick release valves (fig. 8) are installed between the front and rear brake chambers as shown in figure 1. Quick release valves used at front and rear brakes are identical except that the inlet port in valve used at front brakes has 3/8-inch pipe threads and the valve used at rear brakes has 1/2-inch pipe threads. The purpose of the quick release valve is to reduce the time required to release the brakes by hastening the exhaust of air pressure from the brake chambers. The valve consists of a body containing a spring loaded diaphragm so arranged as to permit air pressure to flow through the valve in one direction. When the application pressure is reduced, the air pressure which has passed through the valve is permitted to escape through the exhaust port.

OPERATION (Fig. 8)

The quick release valve assumes three positions during normal operation. These three posi-

tions are the applying position, when air pressure is passing through the valve into the brake chambers; the holding position, when pressure is being held in the brake chambers; and the releasing position, when pressure is being exhausted from the brake chambers.

1. Applying

When air pressure from the brake application valve enters the top connection of the quick release valve, the diaphragm is forced downward, closing the exhaust port. Air pressure then deflects the outer edges of the diaphragm downward and flows out the side connections of the valve to the brake shambers, applying the brakes.

2. Holding

As soon as the brake chamber pressure below the diaphragm equals the pressure from the application valve above the diaphragm, the force of the spring below the diaphragm forces the outer edge of the diaphragm up against the valve body, although the center of the diaphragm keeps the exhaust port closed.

3. Releasing

When the application pressure on top of the diaphragm is reduced, the brake chamber pressure below the center of the diaphragm raises the diaphragm. This opens the exhaust port and permits air pressure from the brake chambers to exhaust through the exhaust port. If the application pressure on top of the diaphragm is only partially released, the diaphragm assumes its holding position as soon as the pressures above and below it are equalized. In this manner, the quick release valve acts to pass any increased application pressure through it to the brake chambers, or quickly releases the brake chamber pressure when the application pressure is reduced. It thus maintains the same pressure in the brake chambers as delivered by the application valve.

SERVICEABILITY TESTS

1. Operating Test

Apply brakes and observe that when the brakes are released, air pressure is exhausted through the exhaust port of the valve. Be sure the exhaust port is not restricted in any way.

2. Leakage Test

With brakes applied, coat the exhaust port with soap suds to detect leakage. Leakage in excess of a 3-inch bubble in 3 seconds is not permissible. Leakage is caused either by dirt on exhaust seat, or by worn exhaust seat.

In case leakage is caused by dirt on exhaust seat, diaphragm should be removed and seat cleaned. If seat on diaphragm is worn, diaphragm should be removed and replaced with a new one. If seat on cover is damaged, the cover should be replaced or the seat lapped as directed later under "Inspection and Repair."

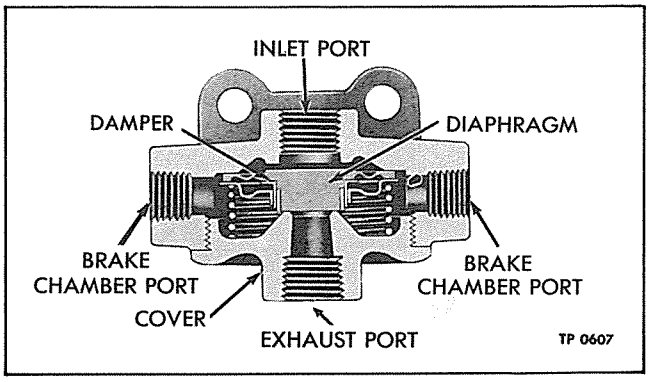

Figure 8—Quick Release Valve

QUICK RELEASE VALVE REPLACEMENT

1. Removal

Exhaust air pressure from system, disconnect air lines from valve, remove mounting bolts, and remove valve from vehicle.

2. Installation

Mount valve in position and connect air lines. Make sure exhaust port is not restricted. Build up air pressure in system and test valve as previously directed under "Serviceability Tests."

QUICK RELEASE VALVE DISASSEMBLY (Fig. 8)

Unscrew cover and lift out diaphragm spring, diaphragm spring seat, damper, and diaphragm.

INSPECTION AND REPAIR

Clean all parts thoroughly. Examine diaphragm for signs of cracking, wear, or damage. Examine the lower face of the diaphragm which contacts the exhaust port seat on the cover for signs of pitting or grooving. Replace diaphragm if these conditions are found. Check condition of exhaust port seat on cover. Seat must be smooth and flat. If seat is scratched or pitted, it can sometimes be repaired by carefully lapping the seat, using fine aluminum oxide abrasive cloth on a flat surface.

QUICK RELEASE VALVE ASSEMBLY (Fig. 8)

With damper positioned on diaphragm, place diaphragm and damper in valve body. Install spring seat, spring, and cover. Tighten cover firmly.

BRAKE CHAMBERS

DESCRIPTION

An air brake chamber (fig. 9) is mounted at each wheel on vehicle as shown in figure 1. Brake chambers used have same internal construction as shown in figure 9, but both front and rear brake chambers have stud type mounting instead of flange type mounting shown. The

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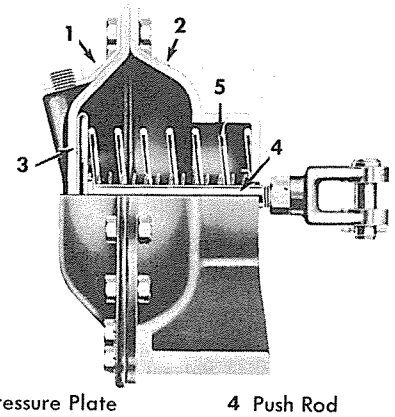

1 Pressure Plate
2 Non-Pressure Plate
3 Diaphragm
4 Push Rod
5 Spring
TP 0619

Figure 9—Brake Chamber (Typical)

purpose of the brake chamber is to convert the energy of compressed air into the mechanical force and motion necessary to operate the mechanical brake assemblies at each wheel. Brake chambers consist essentially of a pressure plate, non-pressure plate, diaphragm, push rod, and springs. The yoke on the push rod connects the push rod to a slack adjuster, which is mounted on brake camshaft.

OPERATION (Fig. 9)

As air pressure enters the brake chamber behind the diaphragm, the diaphragm forces the push rod outward, thus applying force to slack adjuster which rotates brake camshaft, applying brakes. When air pressure is released from the brake chamber, the brake shoe return springs and the push rod springs return the brake shoes, brake camshaft, slack adjuster, push rod, and diaphragm to released position. Due to the extreme sensitivity of the diaphragm, the push rod responds to the slightest variation of air pressure delivered to the brake chamber. This permits the driver to apply or release brakes as rapidly or as gradually as various road or operating conditions warrant.

BRAKE CHAMBER SERVICEABILITY TESTS

1. Operating Test

Apply brakes and see that the brake chamber push rods move out promptly without binding. Release brakes and see that they return to released position promptly without binding.

2. Leakage Tests

a. With brakes fully applied, coat with soap suds the bolting flanges holding the diaphragm in place between the pressure plate and the non-pressure plate. No leakage is permissible. If leakage is evident, tighten flange bolts. All flange bolts must be tightened evenly and only sufficiently to prevent leakage, otherwise the diaphragm will become distorted and premature failure will result.

b. With brakes fully applied, check for leakage through the diaphragm by coating the clearance hole around the push rod and the drain holes in the non-pressure plate with soap suds. No leakage is permissible. If leakage is evident, the diaphragm must be replaced.

3. Check Push Rod Travel

Check push rod travel by holding a rule alongside the push rod while brakes are applied and released. If travel exceeds dimension given under "Specifications" at end of this section, adjust as previously described under "Brake Adjustments" in this section.

BRAKE CHAMBER REPLACEMENT

1. Removal

Disconnect air line. Disconnect push rod yoke from slack adjuster. Remove mounting nuts, then remove brake chamber.

2. Installation

Mount brake chamber in position and connect air line. Connect push rod yoke to slack adjuster. Adjust brakes as previously directed under "Brake Adjustments." Apply brakes and make sure push rod is correct length. Angle formed by push rod and slack adjuster should be slightly greater than 90 degrees with brakes released. If necessary, adjust push rod length by screwing yoke onto or off of push rod. Push rod must not extend through yoke far enough to interfere with slack adjuster. Test brake chamber as previously directed under "Serviceability Tests."

BRAKE CHAMBER DISASSEMBLY (Fig. 9)

1. Before disassembling brake chamber, mark the pressure plate and the non-pressure plate so that the air inlet opening in the pressure plate will be at the correct angle with the mounting studs when re-assembled.

2. Remove all nuts and bolts clamping the outer edges of the diaphragm between the pressure plate and the non-pressure plate. Remove pressure plate and diaphragm.

3. Remove yoke and lock nut from push rod and remove push rod and spring from non-pressure plate.

BRAKE CHAMBER INSPECTION

1. Clean all metal parts thoroughly, using a suitable cleaning fluid.

2. Examine diaphragm and replace with new part if any signs of wear or deterioration are evident. Diaphragms should be replaced every 50,000 miles, or at least every year.

3. Inspect push rod for a bent or distorted condition and replace with new part if such a condition is found.

4. Examine push rod springs and use new parts if weak or broken. It is important when replacing springs to be sure the spring has the same tension as the spring in the brake chamber on the opposite wheel, otherwise, unbalanced braking may result.

BRAKE CHAMBER ASSEMBLY (Fig. 9)

1. Place push rod, springs, and seal washer in non-pressure plate and install lock nut and yoke on push rod.

2. Place diaphragm in pressure plate, with edges of diaphragm inside cupped flange of pressure plate. Position pressure plate and diaphragm on non-pressure plate, being sure the air inlet opening in the pressure plate is in proper relation to the mounting bolts or bracket as marked before disassembly.

3. Install bolts and nuts holding diaphragm between plates. It is important that all bolts be tightened evenly and not excessively. Tighten bolts only sufficiently to insure an airtight seal, but not enough to distort the diaphragm.

SLACK ADJUSTERS

Slack adjusters function as adjustable levers and provide a quick and easy method of adjusting the brakes to compensate for normal lining wear. Type RB slack adjusters are used at both front and rear brakes. Internal construction of front and rear slack adjusters is same as shown in figure 10; however, front slack adjusters have offset lever arms (body) and rear slack adjusters have curved lever arms (body) instead of straight lever arms as shown.

Slack adjuster consists basically of a hardened steel gear, which is splined to the brake camshaft, a brake lever (body), and a hardened steel worm shaft and worm which is mounted in the lever above the gear and meshes with the teeth in the gear. Turning the worm shaft causes rotation of the camshaft in relation to the brake lever. During brake operation, the entire slack adjuster rotates bodily with the camshaft. As brake chamber push rod reaches its maximum travel due to normal lining wear, turning worm shaft rotates lever back to original setting.

SLACK ADJUSTER SERVICEABILITY TEST

Adjust brakes as previously directed under "Brake Adjustment" in this section, then carefully measure brake chamber push rod travel as brakes are applied. Make several full brake applications and again measure push rod travel. Push rod travel should be the same as it was immediately after adjustment. If push rod travel increases, or if difficulty is experienced in keeping the brakes adjusted in service, the slack adjuster must be overhauled or replaced.

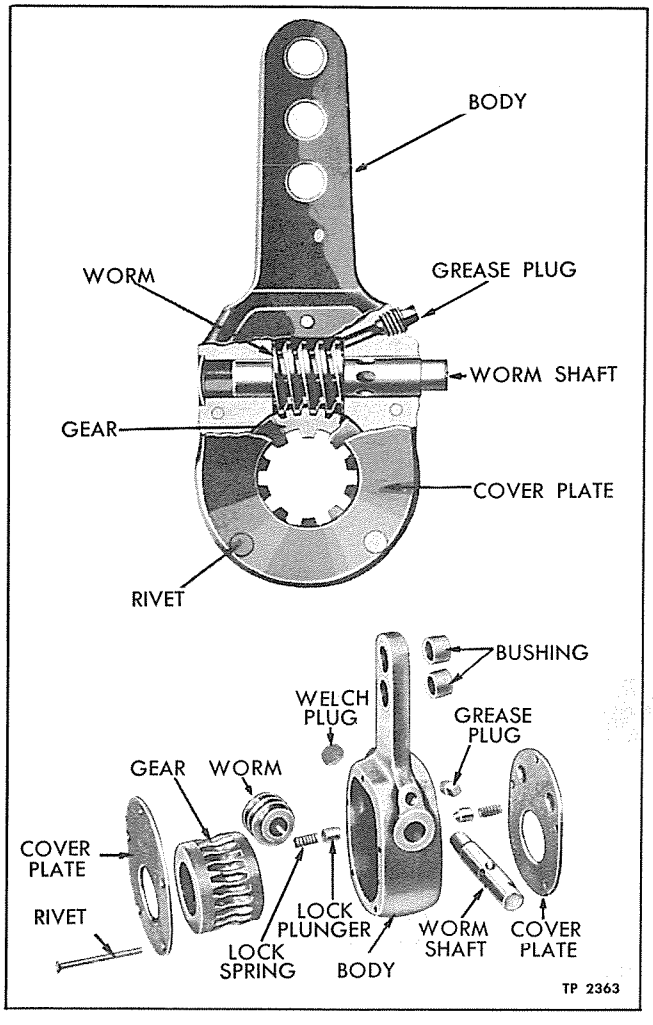

Figure 10—Slack Adjuster (Typical)

SLACK ADJUSTER REPLACEMENT

Removal

1. Remove clevis pin attaching slack adjuster to brake chamber push rod.

2. Remove bolt and washers attaching slack adjuster to camshaft and slide slack adjuster off from shaft.

Installation

1. If a new slack adjuster is being installed, make sure it is the same size and type as the one removed. Slide slack adjuster onto camshaft

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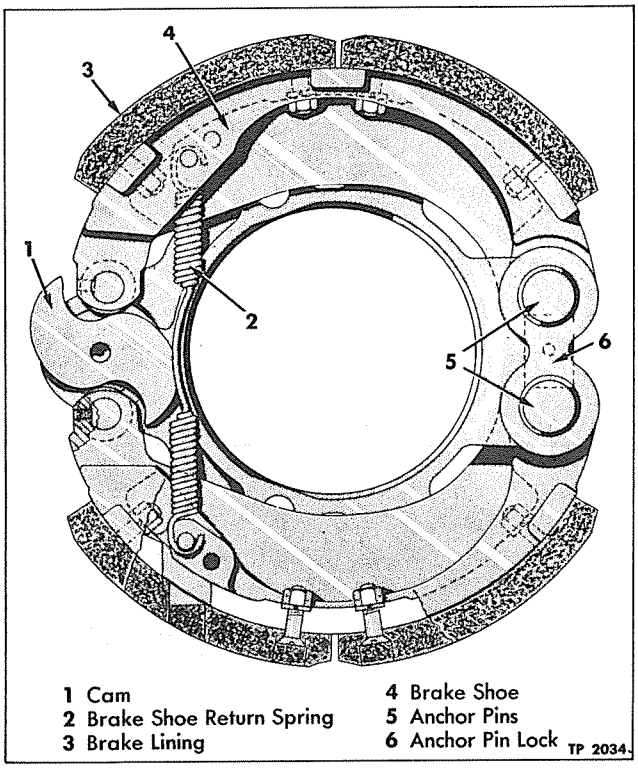

Figure 11—Front Brake Shoes Installed

and attach with bolt and washers.

2. Connect brake chamber push rod to slack adjuster, using clevis pin and cotter pin. Refer to "Brake Chamber Installation" previously in this section for adjustment of brake chamber push rod.

3. Remove grease plug and lubricate slack adjuster as directed in Lubrication (Sec. 13 of this manual).

4. Adjust brakes as previously directed under "Brake Adjustment" in this section.

SLACK ADJUSTER DISASSEMBLY (Fig. 10)

1. Remove dirt and grease from outside of unit by washing in a suitable cleaning fluid.

2. Drill a 1/8" hole in the center of the riveted end of each rivet to the depth of the cover plate. Drive out rivets and remove plates.

3. Remove two lock springs and plungers from body.

4. Remove expansion plug from end of worm shaft bore. Insert a flat end punch into the worm shaft bore and drive out worm shaft.

5. Remove gear and worm from slack adjuster body. Remove grease plug.

INSPECTION AND REPAIR

1. Wash all parts in cleaning fluid and wipe dry.

2. Inspect worm and gear and replace with new parts if chipped or broken teeth are evident.

3. Inspect worm shaft for wear. Side walls of indents must be in good condition.

4. Inspect bushing in lever arm. If worn out-of-round or otherwise damaged, it must be replaced. To replace bushing, press old bushing out and press new bushing into place. Bushing must be reamed after installation to .501" - .503".

5. Examine lever (body) for cracks or distortion. If lever is damaged in any way, a new body and bushing assembly must be used.

SLACK ADJUSTER ASSEMBLY (Fig. 10)

1. Place worm and gear in position in body.

2. Enter small end of worm shaft through hole in body and worm from side having grease plug opening. Press shaft into place until the indents in shaft line up with lock spring bores in body. Install new expansion plug in body.

3. Place lock plungers and springs in bores in body.

4. Position cover plates on body and attach with new rivets. Covers must be flat and in good contact with body after riveting.

5. Connect a grease gun to grease plug opening and force grease into the slack adjuster until it is completely filled. Install grease plug.

FRONT BRAKE SHOES, LININGS AND CAMSHAFTS

SHOES AND LININGS

Brakes at each front wheel have two shoes which pivot on anchor pins at one end and are expanded at other end during brake application by constant lift S-type cams. Brake shoe return springs hold shoe ends firmly against cams as shown in figure 11. Two-piece type lining is bolted to each shoe.

Cam end of each shoe is equipped with a roller which forms the contact between the shoe and the cam. Rollers are mounted on pins which are retained in shoes by set screws. Anchor pin ends of shoes are equipped with replaceable bushings.

ANCHOR PINS

Anchor pins attach one end of each shoe to brake spider. Pins are held in place by a lock plate which fits into notches in the pins and is attached to the brake spider by a cap screw (fig. 11). Anchor pins are drilled and threaded for lubrication fittings.

CAMSHAFTS (Fig. 12)

Front brake camshafts are mounted in needle type roller bearings in brake spider. Bearings are lubricated by applying lubricant through fitting

in spider. Lubricant is retained by seals, installed in brake spider as shown in figure 12.

FRONT BRAKE SHOES AND CAMSHAFT REMOVAL (Figs. 11 and 12)

1. Jack up axle and remove wheel, hub, and brake drum as directed in Hubs and Bearings (Sec. 19A of this manual).

2. Remove brake shoe return spring. Tag or mark shoes so they may be installed in their original position.

3. Remove anchor pin lock plate and push anchor pins out through shoes and spider.

4. Remove shoes by lifting anchor pin ends of shoes out of brake spider.

5. To remove camshaft, disconnect slack adjuster from brake chamber push rod, remove cap screw and lock washer attaching slack adjuster to camshaft, and pull slack adjuster off from shaft. Pull camshaft out of brake spider, stripping washers off shaft as shaft is removed.

INSPECTION

1. Check anchor pins and bushings for wear in accordance with dimensions given under "Specifications" at end of this section. Replace with new parts any that are excessively worn. If bushings are replaced, burnish after installation.

2. Examine camshaft needle bearings and seals. Use new parts if there is any indication of wear or distortion. New seals should be soaked in oil until soft and pliable before installing.

3. Examine cam rollers in end of shoes and replace if worn excessively.

4. Check tension of brake shoe return spring in accordance with "Specifications" at end of this section.

5. Check thickness of brake lining at center of shoe. If worn to 5/16" thickness, lining must be replaced. If new brake linings are used, make sure they are bolted securely to shoe. There should not be more than .006 inch clearance between shoe and lining at any point. Make sure roller in shoe is standard size when new linings are used. Refer to "Specifications" at end of this section.

6. If drums have been machined to oversize and oversize linings used, refer to instructions under "Brake Drums" later in this section.

FRONT CAMSHAFT AND BRAKE SHOES INSTALLATION (Figs. 11 and 12)

1. Work lubricant into camshaft bearings and install new seals if necessary.

2. Place washer over camshaft and insert camshaft through brake spider, being careful not to damage seals.

3. Install brake shoes in the positions from which they were removed by inserting anchor pin ends of shoes between anchor pin brackets on brake spider. Lubricate and install anchor pins and lock in place with lock plate and cap screw.

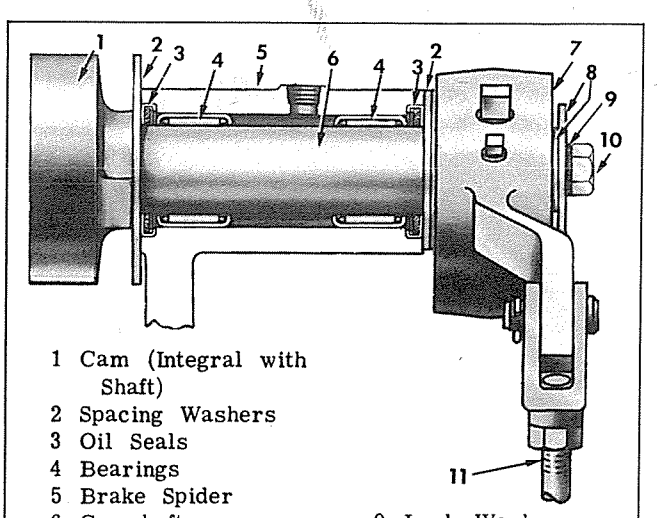

Figure 12—Front Camshaft and Slack Adjuster Mounting

4. Apply a coating of lubricant to cams and brake shoe rollers.

5. Place washer over inner end of camshaft, install slack adjuster on camshaft, and secure in place with flat washer, lock washer, and cap screw.

6. Install hub, drum, and wheel and adjust wheel bearings as directed in Hubs and Bearings (Sec. 19A of this manual).

7. Connect slack adjuster to brake chamber push rod and adjust push rod travel as previously instructed under "Brake Adjustment" in this section. Be sure wheel turns freely when brakes are released.

8. Lubricate slack adjuster, camshaft bearings, and anchor pins as directed in Lubrication (Sec. 13, of this manual).

REAR BRAKE SHOES, LININGS, AND CAMSHAFTS

SHOES AND LININGS

Brakes at each rear wheel have four shoes mounted side by side in pairs. Shoes pivot on anchor pins at one end and are expanded at the other end during brake application by two constant lift S-type cams. Brake shoe return springs hold shoe ends firmly against cams as shown in figure 13.

Cam end of each shoe is equipped with a roller which forms the contact between shoe and

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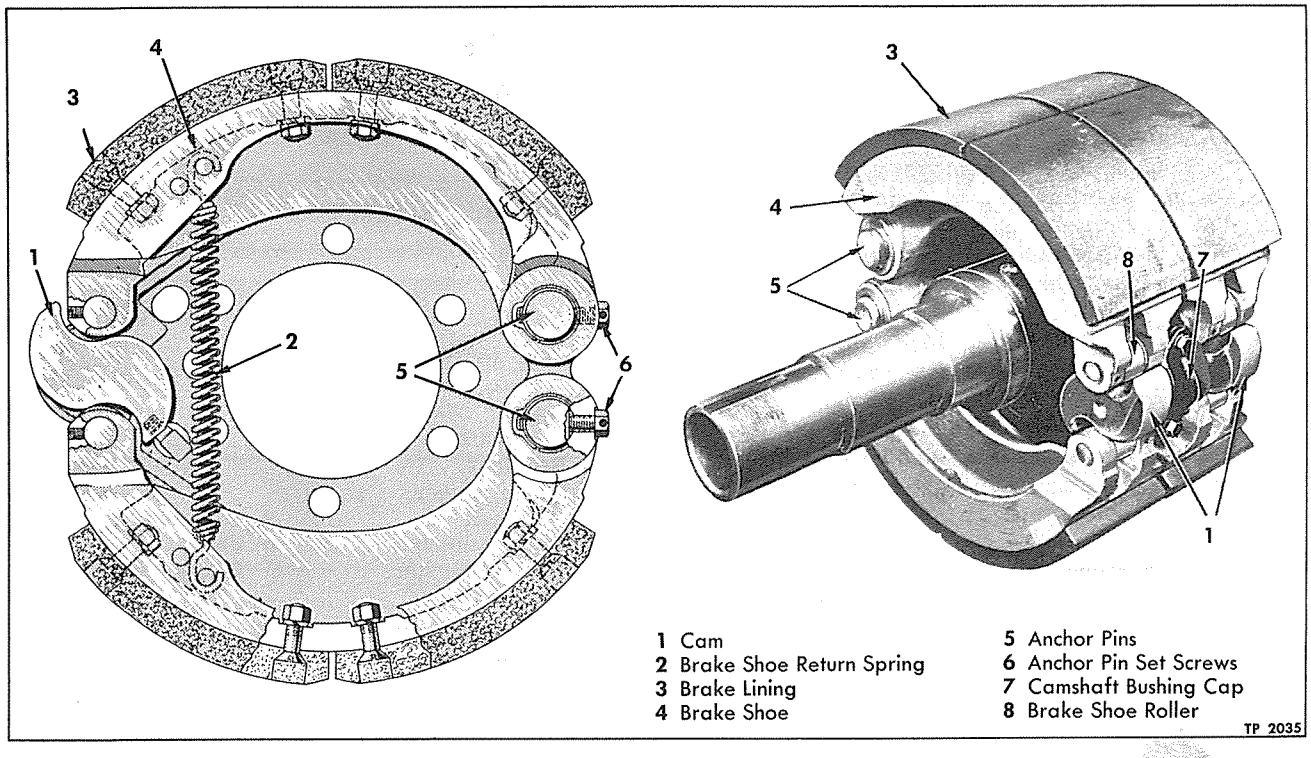


Figure 13—Rear Brake Shoes Installed (Late Vehicles Shown)

cam. Rollers are mounted on pins which are retained in shoes by set screws. Anchor pin ends of shoes are equipped with replaceable bushings.

ANCHOR PINS

Anchor pins attach one end of each shoe to brake spider. Each anchor pin is installed through brake spider and carries a brake shoe on each end. Shoes are held in place on anchor pins by flat washers and locks which fit into grooves in ends of pins. Anchor pins are drilled and threaded for lubrication fittings.

CAMSHAFTS

Two camshaft mounting arrangements are used on vehicles covered by this manual. On early vehicles (fig. 14), both ends of camshaft are carried in needle bearings. On late vehicles (fig. 15), inner end of camshaft is carried in needle bearings and outer end is mounted in bushings in brake spider. Other differences in construction, method of lubrication, and mounting are readily discernible by comparing figures 14 and 15.

REAR BRAKE SHOE REMOVAL (Fig. 13)

1. Jack up rear end of vehicle and remove rear wheels and brake drum. Remove axle shaft as directed in Rear Axle (Sec. 2 of this manual). Remove hub as directed in Hubs and Bearings (Sec. 19A of this manual).

2. Remove brake shoe return springs. Tag or mark shoes so they may be re-installed in their original positions.

3. Remove anchor pin outer locks and washers, then remove outer shoes from anchor pins.

4. Remove anchor pin inner locks and washers, then remove inner shoes from anchor pins.

5. Remove lock wire from anchor pin set screws, loosen set screws, and remove anchor pins from brake spider.

REAR CAMSHAFT REMOVAL

Early Vehicles (Fig.. 14)

1. Perform step 1 under "Rear Brake Shoe Removal."

2. Remove brake shoe return springs and swing shoes out away from cams.

3. Remove bolts attaching camshaft outer bracket from spider and camshaft.

4. Remove lock wire from camshaft collar set screw and loosen set screw.

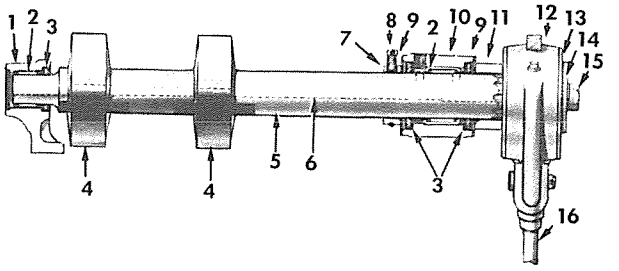
5. Disconnect brake chamber push rod from slack adjuster. Remove bolt and washers attaching slack adjuster to camshaft; remove slack adjuster.

6. Pull camshaft out of inner bracket.

Late Vehicles (Fig. 15)

1. Perform step 1 under "Rear Brake Shoe Removal."

2. Remove brake shoe return springs and swing shoes out away from cams.



1 Camshaft Outer Bracket	9 Camshaft Washer
2 Needle Bearings	10 Camshaft Inner Bracket
3 Oil Seals	11 Spacer
4 Cams (Integral with shaft)	12 Slack Adjuster
5 Camshaft	13 Flat Washer
6 Lubricant Passage	14 Lock Washer
7 Camshaft Collar	15 Bolt
8 Collar Set Screw	16 Brake Chamber Push Rod

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Figure 14—Rear Camshaft and Slack Adjuster Mounting (Early Vehicles)

3. Remove two bolts attaching camshaft bushing cap to brake spider and remove cap.

4. Remove bolt and washers attaching slack adjuster to camshaft and remove slack adjuster.

5. Remove nuts and lock washers attaching camshaft bracket retainer to bracket on axle housing, and lift camshaft and inner bracket as an assembly from axle. Slide inner bracket and bearing assembly off camshaft.

REAR BRAKE SHOES AND CAMSHAFT INSPECTION

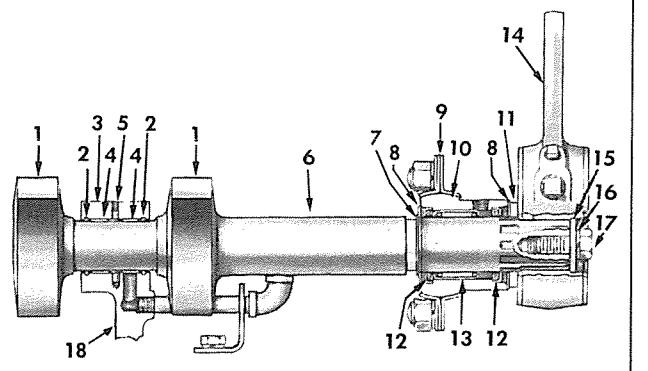
1. Check anchor pins and anchor pin bushings (in shoes) for wear in accordance with dimensions listed in "Specifications" at end of this section. Replace with new parts any that are worn excessively. Make sure lubricant passages in anchor pins are open.

2. Examine needle bearings (or bushings) and seals in camshaft inner and outer brackets. Use new parts if there is any indication of wear or distortion. New seals should be soaked in oil until leather is soft and pliable before installing.

3. Examine cam rollers in ends of shoes and replace if worn excessively.

4. Examine camshafts for cracks, distortion, or wear at the bearing surfaces and cams. On early vehicles (fig. 14), make sure lubricant passages are open.

5. If brake linings are worn to a thickness of 5/16" at center of shoe, they must be replaced. Make sure linings are bolted securely to shoe. There should not be more than .006" clearance between lining and shoe at any point. Make sure rollers in shoes are standard size when new linings



1 Cam (Integral with Shaft)	10 Camshaft Bracket
2 Cork Seals	11 Camshaft Spacer
3 Bushing Cap	12 Oil Seals
4 Bushing	13 Needle Bearing
5 Dowel	14 Slack Adjuster
6 Camshaft	15 Flat Washer
7 Snap Ring	16 Lock Washer
8 Camshaft Washer	17 Bolt
9 Camshaft Bracket Retainer	18 Brake Spider

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Figure 15—Rear Camshaft and Slack Adjuster Mounting (Late Vehicles)

are used. Refer to "Specifications" at end of this section for standard roller diameter.

6. Check tension of brake shoe return springs in accordance with "Specifications" at end of this section. Replace if weak or broken.

7. If brake drums have been machined oversize and oversize linings used, refer to "Brake Drums." later in this section.

REAR CAMSHAFT INSTALLATION

Early Vehicles (Fig. 14)

1. Work lubricant into camshaft needle bearings in camshaft inner and outer brackets. Install new oil seals in brackets if necessary.

2. Place collar and washer over splined end of shaft and insert shaft through inner bracket, being careful not to damage seals.

3. Place outer bracket over outer end of camshaft and attach to brake spider with two bolts. Thread wire through bolt heads and twist ends of wire together.

4. Place washer and spacer on inner end of camshaft and install slack adjuster. Attach slack adjuster to camshaft with flat washer and lock washer. Connect slack adjuster to brake chamber push rod.

5. Position collar against washer at inner bracket and tighten collar set screw. Secure set screw with lock wire.

6. If brake shoes were removed, install shoes as directed later under "Rear Brake Shoe Installa-

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tion." If brake shoes were not removed, install brake shoe return springs, then perform steps 8, 9, and 10 under "Rear Brake Shoe Installation."

Late Vehicles (Fig. 15)

1. Work lubricant into camshaft needle bearing in camshaft inner bracket and install new seals if necessary. Coat bushings in brake spider and bushing cap with lubricant and install new cork seals in spider and cap.

2. Place snap ring and washer over splined end of camshaft, then install inner bracket and bearing assembly on shaft.

3. Position camshaft and inner bracket assembly on axle with inner bracket retainer in place on studs and with bearing surface between cams in place on brake spider.

4. Install nuts and lock washers on bracket retainer studs and tighten firmly. Install bushing cap on brake spider and attach with two bolts. Wire bolt heads together after tightening.

5. Install washer and spacer on inner end of camshaft, then install slack adjuster. Attach slack adjuster to camshaft with flat washer, lock washer, and bolt. Connect slack adjuster to brake chamber push rod.

6. If brake shoes were removed, install shoes as directed later under "Rear Brake Shoe Installation." If shoes were not removed, install brake shoe return springs, then perform steps 8, 9, and 10 under "Rear Brake Shoe Installation."

REAR BRAKE SHOE INSTALLATION (Fig. 13)

1. Coat anchor pins, cams, and brake shoe rollers with lubricant.

2. Position inner shoes and install anchor pins. Anchor pins must be installed with drilled end toward center of vehicle and with milled flat at center of pins adjacent to lock screw holes in brake spider.

3. Install washers and locks on inner ends of anchor pins.

4. Install return spring on inner shoes.

5. Install outer shoes on anchor pins and install outer washers and locks on anchor pins.

6. Tighten anchor pin set screws and wire set screw heads together.

7. Install return spring on outer shoes.

8. Back off slack adjuster adjusting screw until shoe rollers are at lowest points on cams.

9. Clean and lubricate bearings, install hub and bearings, install brake drum and wheels, and adjust wheel bearings as directed in Hubs and Bearings (Sec. 19A of this manual).

10. Adjust brakes as previously directed under "Brake Adjustment" in this section.

BRAKE DRUMS

If brake drums are scored, they may be machined or ground to .030 inch beyond original diameter without requiring the use of oversize lining. (See "Specifications" for original diameter.) If drums are scored enough to require machining in excess of .030 inch, they should be machined to 1/8 inch (.125) inch) over original diameter and 1/16 inch oversize lining should be installed on brake shoes. After oversize lining has worn down so that roller on shoe passes high point on cam without effectively applying brakes, a 1/2 inch oversize diameter roller should be installed in shoes. By installing oversize rollers, effective brakes are obtained without necessitating replacing linings. However, when maximum wear has been obtained through the use of oversize rollers, and new oversize linings are being installed, oversize rollers must be replaced with standard rollers.

Brake drums should never be machined to more than 1/8 inch beyond original diameter. Drums might become warped or bell shaped if more metal than this were removed. If machining to 1/8 inch oversize will not clean up drums, new drums must be used.

SPECIFICATIONS

	FRONT	REAR	
		Early Vehicles*	Late Vehicles**
BRAKE DRUM			
Diameter	14.490" - 14.510"	14.490" - 14.510"	14.490" - 14510"
Maximum Allowable Out-of-round	0.010"	0.010"	0.010"
Regrinding Limits (beyond original diameter)			
Using Standard Lining	0.030"	0.030"	0.030"
Using Oversize Lining	0.125"	0.125"	0.125"
BRAKE LINING			
Length - each piece(2 pieces per shoe)	7.33"	7.33"	7.33"
Width	6"	4"	4"
Thickness	3/4"	3/4"	3/4"
Area Per Wheel	176 sq. in.	234.5 sq. in.	234.5 sq. in.
BRAKE SHOE RETURN SPRING			
Free Length	8-3/8"	9-1/8"	9-1/8"
Length @ - lbs. pull	9" @ 50-60 lbs.	9-3/4" @ 85-95 lbs.	9-3/4" @ 85-95 lbs.
CAMSHAFT			
Diameter at Bearing	1.495" - 1.493"	1.495" - 1.493"	1.495" - 1.493"
Diameter at Spider (rear only)	----------	0.995" - 0.997"	1.368" - 1.370"
Spider Bushing I.D.(Late vehicles)	----------	----------	1.374" - 1.376"
CAM ROLLER IN SHOE			
Standard Roller Diameter	1.248" - 1.252"	1.248" - 1.252"	1.248" - 1.252"
Oversize Roller Diameter	1.748" - 1.752"	1.748" - 1.752"	1.748" - 1.752"
Roller Side Clearance (Approx.)	0.033"	0.033"	0.033"
Roller Pin Diameter	0.748" - 0.749"	0.748" -0.749"	0.748" - 0.749"
Diameter of Hole in Roller	0.754" - 0.756"	0.754" - 0.756"	0.754" - 0.756"
ANCHOR PINS AND BUSHINGS			
Pin Diameter at Bushings	1.248" - 1.250"	1.248" - 1.250"	1.248" - 1.250"
Pin Length	4-3/8"	7-9/32"	7-9/32"
Bushing Diameter			
Inside	1.254" - 1.256"	1.254" - 1.256"	1.254" - 1.256"
Outside	Tight in shoe	Tight in shoe	Tight in shoe
Bushing Length	1-15/16"	1-15/16"	1-15/16"
Diameter of Hole in Shoe	1.373" - 1.375"	1.373" - 1.375"	1.373" - 1.375"
BRAKE CHAMBERS			
Type	C	G	G
Spring Force at 3/4" Stroke	29-1/2 $\pm$ 3 lbs.	55 $\pm$ 6 lbs.	55 $\pm$ 6 lbs.
Minimum Stroke when Brakes are Adjusted	3/4"	3/4"	3/4"
Adjust when Stroke Reaches (Max.)	1-3/4"	1-3/4"	1-3/4"

* One piece axle housing (cover integral with housing).
** Axle housing cover welded to axle housing.

AIR BRAKES

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference - Make note of bulletin number in space below:

NOTES

Air Compressor and Governor

Contents of This Section

Related Subjects in Other Sections

Air compressor is a two-cylinder, single acting, reciprocating type unit with unloading type head. Compressor is flange mounted to the engine gear train cover, lubricated by the engine lubrication system, and the cylinder head is cooled by the engine cooling system.

Compressor has a rated capacity of seven and one-quarter cubic feet per minute, based on its piston displacement when running at a speed of 1250 rpm.

COMPRESSOR DRIVE AND LUBRICATION

An internal fiber toothed hub is keyed to front end of compressor crankshaft and secured by a nut and cotter pin (fig. 1). An internal toothed fiber drive disc is attached to engine camshaft gear by four cap screws. A drive coupling with external teeth at each end is carried in the internal teeth of the hub and drive disc, transmitting power from disc to compressor crankshaft.

Oil, under pressure from engine lubrication system, enters drilled crankshaft through crankshaft end cover and is forced through crankshaft and drilled connecting rods, lubricating bearings, piston pins, and pistons. Oil returns to engine through an oil return line connected to drain hole in compressor crankcase cover.

COMPRESSOR AIR INTAKE

Air compressor has forced air intake system, Compressor air inlet manifold is connected by a tube to the left rear hand hole cover on the engine air box. When each compressor piston is at the bottom of its stroke and the air intake ports in the cylinder wall are uncovered, air pressure in the engine air box forces air into the compressor cylinder. This tends to supercharge the compressor, since a greater volume of air flows into the compressor cylinders than when the conventional atmospheric air intake sys-

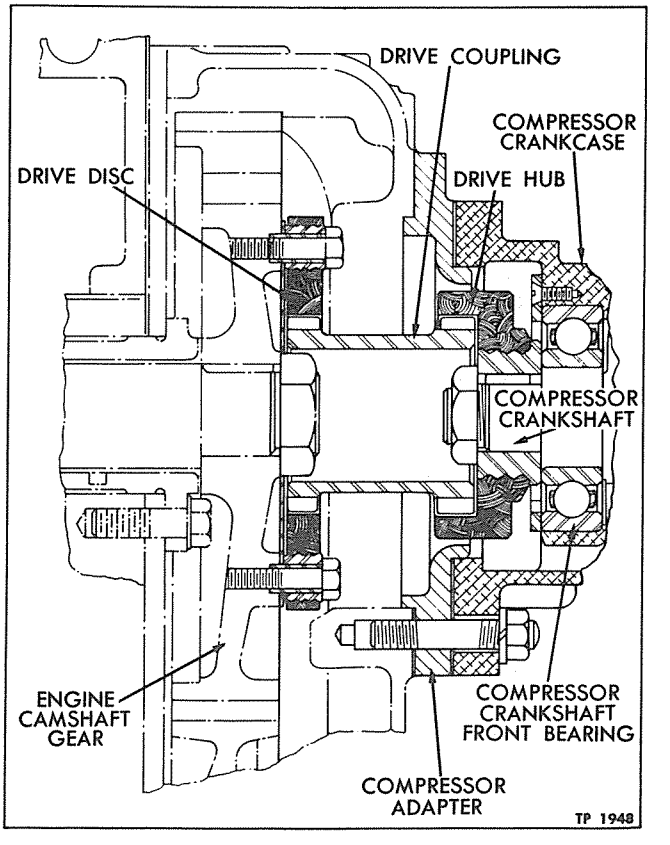

Figure 1—Air Compressor Drive (Typical)

AIR COMPRESSOR

tem is used. The use of this type air intake system also eliminates the necessity of an air compressor air cleaner, since the air in the engine air box is cleaned by the engine air intake system air cleaners.

COMPRESSOR OPERATION

Air compressor crankshaft turns continuously while engine is running, but actual compression of air is controlled by the compressor governor. Acting in conjunction with compressor unloading mechanism, governor controls compression when pressure in air system reaches the desired maximum or minimum. Air line connections at compressor and governor are illustrated in Air Line Diagrams in Air Brakes (Sec. 4B of this manual).

OPERATION WITH UNLOADING VALVES CLOSED (COMPRESSING) (Figs. 2 and 3)

During the downstroke of each piston, a partial vacuum is created above the piston. As the piston nears the bottom of its stroke, it uncovers intake ports in the side of the cylinder wall. Air from the engine air box is then forced into the cylinder through the inlet ports.

As each piston begins its upstroke, it covers the air intake ports in the cylinder wall and the air which has entered the cylinder is trapped above the piston. As the piston continues its upstroke, the air above the piston is compressed. When air pressure in the cylinder becomes greater than the pressure in the cylinder head above the discharge valve, it forces the discharge valve off its seat and passes out through the discharge port into the air line leading to the air tank.

As the piston starts its downstroke, the discharge valve returns to its seat, preventing the compressed air from returning to the cylinder and the intake and compression cycle is repeated.

OPERATION WITH UNLOADING VALVES OPEN (NOT COMPRESSING) (Figs. 2 and 3)

When air pressure in the air system reaches the maximum pressure for which the governor is set, air pressure passes through the governor into the cavity below the diaphragm in the compressor cylinder head, deflecting the diaphragm upward. Movement of diaphragm is transmitted through the diaphragm follower and dust guard to the lower end of the unloading valve lever. As the lower end of the valve lever is forced upward, lever pivots on lever pin and the upper end of the lever moves downward. Downward movement of the valve lever forces the unloading valves off their seats. With the unloading valves off their seats, the unloading cavity in the cylinder head forms a passage between the cylinders above the pistons. Thus during the upward stroke of each piston, air merely passes back and forth through this passage and compression is stopped.

When the air pressure in the air system is reduced to the governor cut-in setting, the governor releases the air pressure from the cavity below the diaphragm, the unloading valve springs return the unloading valves to their seats, and compression of air is resumed.

COMPRESSOR MAINTENANCE

It is important that the inspection and adjustments given below be made at intervals determined by severity of service.

1. Remove cylinder head and clean carbon away from discharge and unloader valves.
2. Check compressor discharge line. Make sure line is not choked with carbon.
3. Adjust clearance between top of unloading valves and bottom of adjusting screws to .010 to .015 inch.
4. Check compressor and support bracket mounting bolts and tighten if necessary.
5. Oil unloading valve lever pin.
6. Remove diaphragm cover and inspect unloading diaphragms. Replace diaphragms if damaged.
7. Make sure water and air line connections are tight and not leaking.
8. When draining engine cooling system, be sure and remove drain plug from compressor cylinder head.

COMPRESSOR REPLACEMENT

REMOVAL

1. Drain cooling system.
2. Disconnect water, air, and oil lines from compressor.
3. Disconnect air inlet tube from air inlet elbow on compressor cylinder block.
4. Remove nuts from three studs attaching air compressor to gear train cover. Pull compressor straight off from studs and remove from vehicle. Remove compressor adapter from mounting studs.

INSTALLATION (Fig. 1)

1. Before installing compressor, examine hub on compressor crankshaft and drive disc on camshaft gear for worn or broken teeth. Check backlash between teeth in hub and teeth on drive coupling, also between teeth in drive disc and teeth on coupling. New limits are .000 to .001 inch backlash. If backlash is appreciably greater than this, disc or hub (or both) must be replaced.
2. Make sure mating surfaces of air compressor, air compressor adapter, and gear train cover are clean. Place new adapter to gear train cover gasket over mounting studs, install adapter, then

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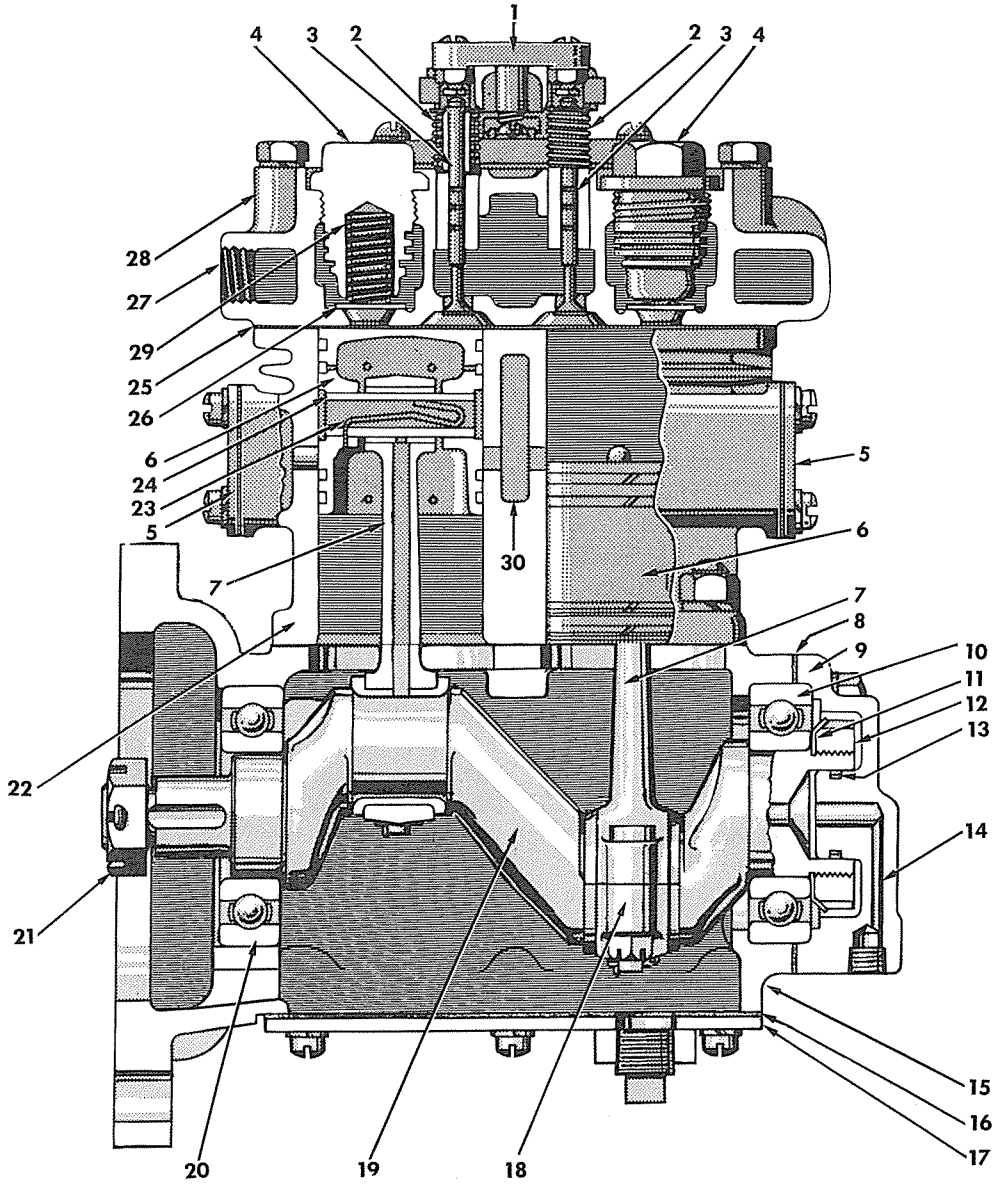

1 Unloading Valve Lever
2 Unloading Valve Spring
3 Unloading Valve
4 Discharge Valve Cap Nut
5 Blanking Cover
6 Piston
7 Connecting Rod
8 Rear End Cover Gasket
9 Rear End Cover
10 Crankshaft Rear Bearing
11 Crankshaft Rear Bearing Nut Lock
12 Crankshaft Rear Bearing Nut
13 Crankshaft Seal Ring
14 Oil Inlet Passage
15 Crankcase
16 Bottom Cover Gasket
17 Crankcase Bottom Cover
18 Connecting Rod Cap
19 Crankshaft
20 Crankshaft Front Bearing
21 Crankshaft Nut
22 Cylinder Block
23 Piston Pin Lock
24 Piston Pin
25 Cylinder Head Gasket
26 Discharge Valve
27 Water Line Connection
28 Cylinder Head
29 Discharge Valve Spring
30 Air Inlet Passage

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Figure 2—Air Compressor—Sectional View

AIR COMPRESSOR

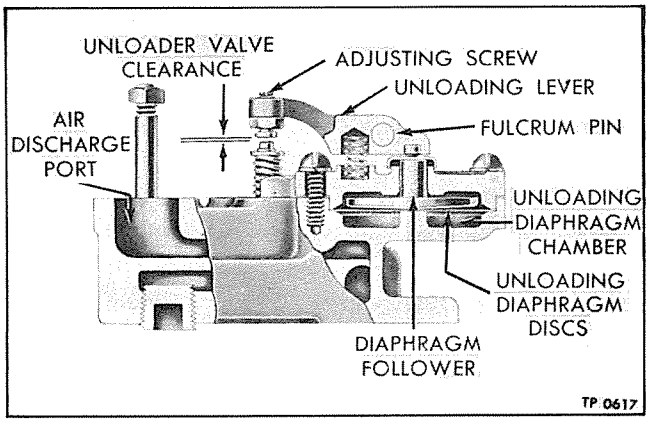


Figure 3—Air Compressor Cylinder Head

place compressor to adapter gasket on studs.

3. Insert one end of drive coupling into hub on compressor crankshaft, then place compressor in position on gear train cover, guiding teeth on coupling into mesh with teeth in drive disc. Install nuts and lock washers on studs and tighten firmly.

4. Connect air inlet tube to air inlet elbow on side of cylinder block.

5. Connect oil, water and air lines to compressor, using aviation type permatex on fittings.

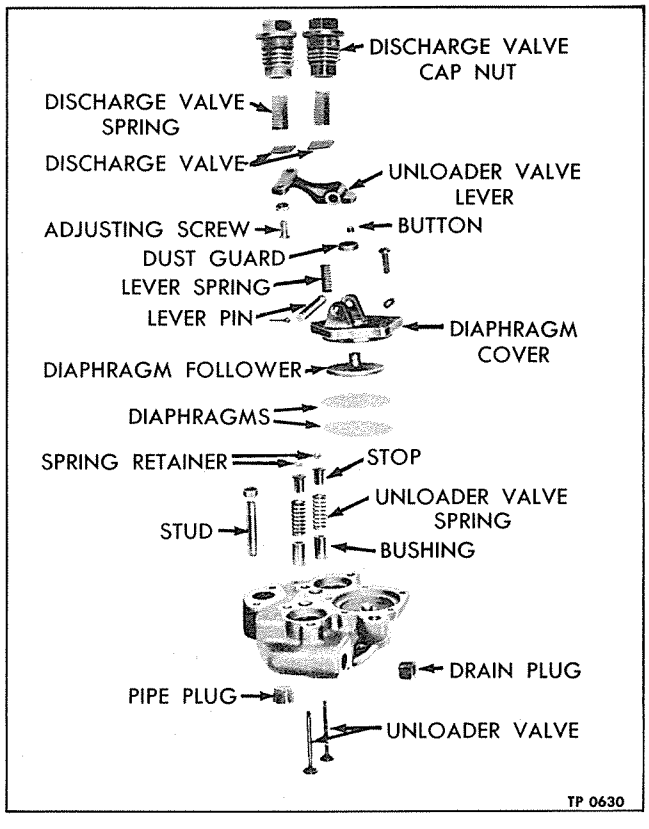


Figure 4—Compressor Cylinder Head Disassembled

6. Make sure plug is installed in cylinder head, then fill cooling system (refer to Cooling System, Sec. 6A of this manual).

COMPRESSOR DISASSEMBLY

The cylinder block, cylinder head, crankcase, and air inlet elbow are so designed that they may be assembled in different ways to meet installation requirements; therefore, these parts should be marked prior to disassembly so they may be assembled in correct relationship to each other. Remove air inlet elbow from side of cylinder block.

CYLINDER HEAD REMOVAL AND DISASSEMBLY (Fig. 4)

1. Remove nuts from all cylinder head studs and lift off cylinder head assembly. The cylinder head may have to be tapped lightly with a rawhide hammer to break the gasket joint. Scrape cylinder head gasket off cylinder head and cylinder block.

2. Remove cotter pins from unloading valve lever pin and drive out pin. Remove unloading valve lever, lever spring, and dust guard. Remove adjusting screws and lock nuts from lever.

3. Remove screws and lock washers attaching diaphragm cover to cylinder head. Lift off cover and remove diaphragm follower and two diaphragms.

4. Remove discharge valve cap nuts and lift out discharge valve springs. Invert head to allow discharge valves to fall out.

5. Compress unloading valve springs and remove spring retainers, then remove springs and stops from valve stems. Remove unloading valves by pushing them out bottom of cylinder head.

PISTON AND CONNECTING ROD REMOVAL AND DISASSEMBLY (Fig. 2)

1. Before removing pistons, mark each piston so it may be installed in original position in proper cylinder. Connecting rods and caps are marked to show proper position of cap on rod.

2. Remove cover and gasket from bottom of crankcase.

3. Remove nuts from connecting rod bolts and remove connecting rod bearing caps. Push pistons with connecting rods attached out the top of the cylinder block. Replace caps on connecting rods to prevent damage to bearings.

4. Remove piston rings from pistons. If pistons are to be removed from connecting rods, remove piston pin locks and press piston pins out of pistons and connecting rods.

CRANKSHAFT REMOVAL

1. Remove cotter pin and nut from forward end of crankshaft and pull drive hub off from

shaft, using a suitable puller.

2. Remove nuts and lock washers from studs securing rear end cover to crankcase and remove end cover and gasket.

3. Remove nut and nut lock from rear end of crankshaft.

4. Press crankshaft and bearings out rear end of crankcase, then press bearings off from crankshaft.

CYLINDER BLOCK REMOVAL (Fig. 2)

1. Remove nuts and lock washers attaching cylinder block to crankcase and remove cylinder block and gasket.

CLEANING AND INSPECTION OF COMPRESSOR PARTS

CLEANING

1. General. Thoroughly wash all parts in a suitable cleaning fluid to remove all traces of dirt, oil, or grease.

2. Cylinder Head. Soak cylinder head body in cleaning fluid to loosen carbon from discharge valve cavities and unloading valve cavity, and to loosen rust and scale. Use compressed air to blow dirt out of all cavities. Scrape carbon, dirt, or particles of old gasket from all surfaces.

3. Discharge Valves. If discharge valves are not worn excessively or damaged, they may be cleaned by lapping them on a piece of crocus cloth on a flat surface.

4. Oil Passages. Thoroughly clean all passages through crankshaft, connecting rods, crankcase, and rear end cover. If necessary, prod oil passages with a piece of wire, flush with cleaning fluid, and blow out with compressed air.

5. Cylinder Block. Soak cylinder block in cleaning fluid to loosen carbon and dirt from intake manifold and intake ports. Blow dirt out with compressed air.

6. Ball Bearings. Immerse bearings in cleaning fluid, clean with a brush to remove old lubricant. Blow bearings dry with compressed air, then wrap in a clean cloth.

INSPECTION

1. Cylinder Head. Inspect cylinder head body for cracks or breaks; replace head if any are found. Check condition of unloading diaphragm seat in diaphragm cavity. Replace cylinder head body if seat is damaged in any way. Inspect unloading valve seats in bottom of cylinder head. If seats are pitted or worn they must be reamed as directed later in this section under "Compressor Repair." Test cylinder head water jacket for leakage, using air pressure. Replace cylinder head body if leakage is evident.

2. Unloading Lever Pin. Check fit of unloading lever pin in unloading lever. If excessive play is evident, replace lever or pin, or both.

3. Unloading Diaphragms and Cover. Inspect diaphragms and replace if any signs of wear or cracking are present. Examine diaphragm seat on bottom of diaphragm cover. Lap seat or replace cover as necessary.

4. Unloading Valves and Bushings. Check fit of unloading valve stems in unloading valve bushings; valve stems must be a neat sliding fit in bushings. If excessive clearance is evident, check valve stems for wear. Wear of the valve stems must not exceed .002 inch. Wear may be checked by comparing the diameter of the valve stem where it engages the bushing with the diameter of the stem where it does not engage the bushing. If clearance between valve stems and bushings is excessive, valves, bushings, or both must be replaced as directed later under "Compressor Repair" in this section.

5. Discharge Valve Springs. Discard all used discharge valve springs and replace with new springs.

6. Discharge Valves and Seats. Inspect discharge valves and seats. If discharge valves are grooved deeper than .003 inch where they contact the seats, they must be replaced. Valves which are scratched or only slightly grooved may be repaired by lapping valves with a fine abrasive powder on a surface plate. If discharge valve seats are worn or pitted, they must be reconditioned as directed later under "Compressor Repair" in this section.

7. Crankcase and End Cover. Check crankcase and end cover for cracks or broken lugs. Replace with new parts if damaged. Check fit of oil seal ring in groove in rear end cover. Ring must be a neat fit in groove and must have .008 to .015 inch clearance at the gap when placed in the end bore of the crankshaft.

8. Crankcase Bearing Bores. Check fit of ball bearings in crankcase. Bearings must be a light press fit in bores. If the crankcase bearing bores are worn or damaged, the crankcase must be replaced.

9. Cylinder Block. If cylinder block is cracked or damaged in any way, it must be replaced. Examine cylinder bores for scoring, out-of-round, and taper. Bores may be checked for out-of-round and taper using an inside micrometer as shown in figure 5. Bores which are scored or out-of-round more than .003 inch, or tapered more than .003 inch must be rebored, ground, or honed oversize. Pistons are available in .010, .020, and .030 inch oversize. Cylinder bores must be smooth, straight, and round, and must be finished with a 500 (or finer) grit hone. Clearance between piston and cylinder wall must not be less than .002 inch or more than .004 inch.

AIR COMPRESSOR

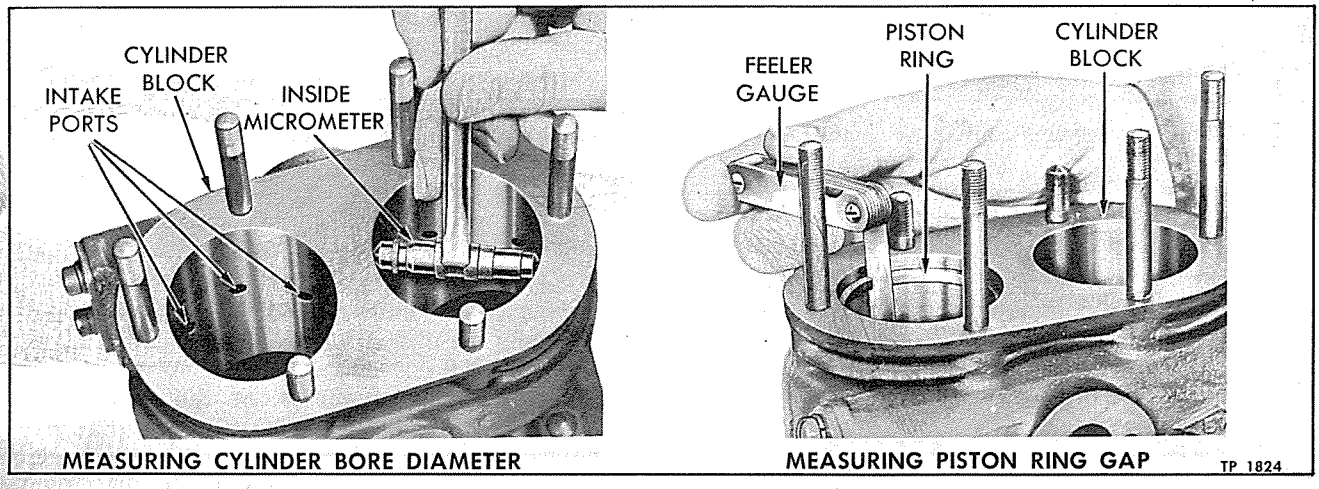


Figure 5—Compressor Cylinder Bore and Piston Ring Inspection

10. Pistons. Examine pistons for scoring, cracks, or damage of any kind. Measure outside diameter of piston with a micrometer and compare this measurement with inside diameter of cylinder bore. If piston is more than .004 inch smaller than the cylinder bore, piston must be replaced with an oversize piston.

11. Piston Pins. Check fit of piston pins in pistons and connecting rods. Pins must be a light press fit in pistons. If piston pin is loose in piston, the pin, piston, or both must be replaced. Check fit of piston pins in connecting rod bushings by rocking the pins in the bushings. If looseness is evident, replace the connecting rod bushings as directed later under "Compressor Repair" in this section. Discard all used piston pin locks.

12. Piston Rings. Check fit of piston rings in ring grooves in pistons (fig. 6). Clearance between the ring and the ring groove must not be less than .0015 inch or more than .0025 inch. Install ring in cylinder bore and measure ring gap (fig. 5). Used rings which have a gap of more than .020 inch must be replaced. New rings must have .010 to .015 inch gap.

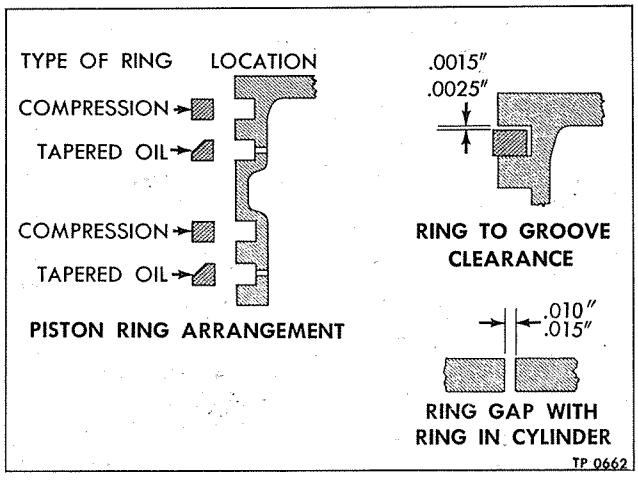


Figure 6—Piston Ring Arrangement and Clearances

13. Connecting Rod Bearings. Check fit of connecting rod bearings on crankshaft journals. Clearance between side of connecting rod bearing and check on crankshaft must not exceed .015 inch. Clearance between bearing and crankshaft journal must not exceed .002 inch. Replace rods or rebabbitt bearings if babbitt is worn, cracked, or flaked.

14. Crankshaft. Crankshaft journals which are out-of-round more than .001 inch or bruised must be reground. When regrinding, the fillets at the ends of the journals must be maintained. Connecting rods are available .010, .020, and .030 inch undersize for reground crankshafts. Threads, keyways, tapered ends, and all ground and machined surfaces must not be mutilated or excessively worn. Main bearing journal must not be worn sufficiently to prevent ball bearings being a light press fit.

15. Ball Bearings. Examine bearings for wear or flat spots and replace if damaged.

16. Springs. Check tension of all springs in accordance with "Specifications" at end of this section and replace any which are weak or broken.

COMPRESSOR REPAIR

UNLOADING VALVE BUSHINGS

If unloading valve bushings require replacement as previously indicated in step 4 under "Inspection," remove bushings by pressing them out through the top of the cylinder head. Press new bushings into place.

UNLOADING VALVES AND SEATS

Unloading valves which are not too badly worn may be ground to their seats using grade 1000

grinding compound, valve grinding tool (BWE-202812), and driver bit (BWE-230197). If the valve seats are badly pitted or worn, they must be reamed using special reamer (BWE-213606). Valves must be ground to their seats after reaming. After grinding, wash valves and seats with cleaning fluid.

DISCHARGE VALVE SEATS

1. If discharge valve seats are only slightly scratched, repair by using grade 1000 grinding compound, lapping disk (BWE-230194), grinding tool (BWE-202812), and driver bit (BWE-230197). If valve seats are pitted, use lapping stone (BWE-221622) before using lapping disk and grinding compound. If seats are badly pitted or scratched, use reamer (BWE-221614) before using lapping stone or lapping disk.

2. Place discharge valves on valve seats, install discharge valve springs in discharge valve cap nuts, and thread cap nuts firmly into cylinder head. To test discharge valves for leakage, connect air line to the discharge port in the cylinder head. Apply 100 pounds air pressure to valves and apply soap suds to discharge valve openings in bottom of head. Leakage in excess of a 1-inch bubble in one second is not permissible. If leakage is excessive, leave the air pressure applied and, using a fiber or hardwood dowel and a light hammer, tap the discharge valves off their seats several times to improve the seal between the valves and seats. Leakage should also be checked by applying soap suds around the top of the discharge valve cap nuts. Leakage at this point must not exceed a 1-inch bubble in five seconds.

CONNECTING ROD BUSHINGS

If piston pin bushings in connecting rods require replacement as previously indicated in step 11 under "Inspection," press old bushings out of connecting rods. Press new bushings into place, making sure that the oil holes in the bushings line up with the oil passages in the connecting rods. Bushings must then be reamed, honed, or bored to provide between .0005 and .001 inch clearance on the piston pin.

COMPRESSOR ASSEMBLY

CYLINDER BLOCK INSTALLATION

1. Place new cylinder block to crankcase gasket over studs on crankcase. Position cylinder block on crankcase, aligning marks made prior to disassembly. Install nuts and lock washers on studs and tighten firmly.

CRANKSHAFT INSTALLATION

1. Press crankshaft rear bearing onto rear end of crankshaft. Install nut lock and nut on rear end of shaft, tighten nut firmly, then bend lip of nut lock over against flat of nut.

2. Insert forward end of crankshaft through bearing bore in rear end of crankcase and press bearing into crankcase until it is bottomed against shoulder in crankcase.

3. Install seal ring in seal ring groove in boss on forward side of rear end cover. Position new gasket over rear end cover studs. Install rear end cover over studs, making sure the seal ring enters the bore in rear end of crankshaft. Install nuts and lock washers on studs and tighten firmly.

4. Install crankshaft front bearing on front end of crankshaft and press bearing onto shaft and into crankcase until the bearing inner race bottoms against the shoulder on crankshaft.

5. Install key in keyseat in forward end of crankshaft, install drive hub on shaft, and secure with nut and cotter pin.

PISTON AND CONNECTING ROD ASSEMBLY AND INSTALLATION

1. Position connecting rod in piston and press piston pin into piston, making sure that the piston pin lock hole lines up with the lock hole in the piston. Install new piston pin lock in piston pin with the lock engaging holes in pin and piston.

2. Install piston rings in grooves in pistons by hand. Four rings are used on each piston and they must be installed in their proper location as shown in figure 6. Careful inspection is necessary to determine which side of the tapered oil ring has the largest diameter. Tapered oil rings are marked with a small diamond shaped trade mark on the top side of the ring opposite the gap, and the ring must be installed with the trade mark toward the top of the piston. Compression rings are marked with a small diamond shaped trade mark near the gap and must be installed with the trade mark side toward the top of the piston.

3. Thoroughly lubricate pistons, piston rings, piston pin bushings, and connecting rod bearings with clean engine oil.

4. Turn crankshaft so as to position No. 1 crankshaft journal downward. Remove bearing cap from No. 1 connecting rod, leaving connecting rod bolts in the rod. Connecting rods must be installed so that the center punch markings are at the front or name plate side of the compressor.

5. Insert No. 1 connecting rod and piston through top of No. 1 cylinder, being sure the connecting rod bearing engages the connecting rod

AIR COMPRESSOR

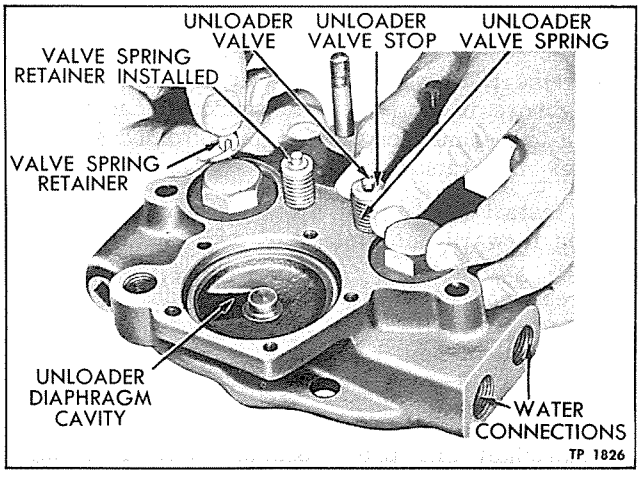


Figure 7—Installing Unloading Valves

journal properly. Install bearing cap and attach with two nuts.

6. Install No. 2 piston and connecting rod in same manner as in step 5 above.

7. Position crankcase bottom cover and new gasket on crankcase and attach with six cap screws and lock washers.

CYLINDER HEAD ASSEMBLY AND INSTALLATION

1. Insert each unloading valve into cylinder head body from bottom side. Place a small wooden block or a nut under each valve to hold it up against seat as head is set on bench. Install unloading valve spring over each valve, then place stop on top of each spring. Compress each unloading valve spring by hand and install spring retainer on valve stem above stop (fig. 7).

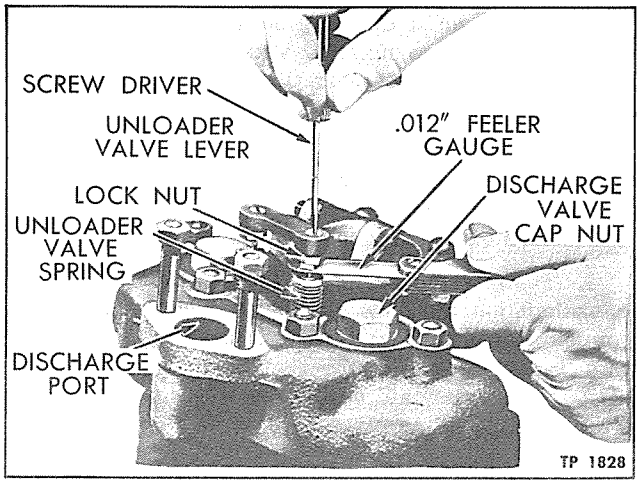


Figure 8—Adjusting Unloading Valves

2. Place each discharge valve on its seat through opening in top of cylinder head. Place discharge valve springs in discharge valve cap nuts, then thread cap nuts into cylinder head. Tighten nuts firmly.

3. Lubricate unloading diaphragms with a thin coating of light engine oil and place diaphragms in cavity in top of cylinder head. Place diaphragm follower in position on diaphragms with post upward. Install diaphragm cover over diaphragm follower post and attach cover to cylinder head with screws and lock washers. Tighten screws.

4. Check for leakage past unloading diaphragms by applying 100 pounds pressure to the unloading diaphragm cavity port and apply soap suds all over the diaphragm cover, particularly around the diaphragm follower post. Leakage in excess of a 1-inch bubble in three seconds necessitates disassembly and correction of leakage.

5. Place dust guard in position over end of diaphragm follower post.

6. Install adjusting screws in unloading valve lever with the screw heads and nuts on the under side of the lever.

7. Place unloading valve lever spring in recess in diaphragm cover and position lever over spring. Insert lever pin through diaphragm cover and lever and install a cotter pin in each end of pin.

8. Install drain plug in bottom of cylinder head if it has been removed.

9. Install a new cylinder head gasket over studs so the cut-outs in the gasket will register with the unloading valves when the cylinder head is installed. Install cylinder head on cylinder block so the air discharge port will be on the right-hand side when compressor is viewed from drive end. Install cylinder head stud nuts and tighten firmly.

10. Install air inlet elbow on side of cylinder block, using new gasket.

11. Adjust unloading valves as directed below.

COMPRESSOR UNLOADING VALVE CLEARANCE ADJUSTMENT

Turn adjusting screws in unloading lever as shown in figure 8 until clearance between the head of the adjusting screws and the end of the unloading valve stems is within .010 to .015 inch. This adjustment is important since too much clearance will not permit the valves to open sufficiently to unload the compressor, while no clearance may hold the valves open and the compressor will not compress air.

COMPRESSOR TESTS

After overhauling air compressors, it is recommended that they be subjected to the following tests to determine if they are operating properly. Connect an oil supply line having at least 15 pounds pressure to compressor rear end cover opening. Plug oil inlet passage in bottom of crankcase during test. Provisions must be made for drainage of oil from crankcase during test. Water must be circulated through compressor cylinder head while compressor is operating.

RUN-IN TEST

With compressor connected to a suitable source of power to run compressor at 1250 rpm, run compressor for one-half hour with discharge port open to atmosphere. Closely check compressor during this test for oil leaks, overheated bearings, and excessive noise.

EFFICIENCY TEST

Efficiency test is made by running compressor for one-half hour with exhaust port connected to an air tank. With a 1/16-inch diameter relief hole in air line open continuously, the compressor should maintain a pressure of at least 47 pounds.

AIR COMPRESSOR GOVERNOR

Governor, operating in conjunction with compressor unloading mechanism, automatically limits system pressure to a predetermined range by opening unloader valves and stopping compression when pressure has been built up to maximum limit, or by closing valves and starting compression when system pressure has dropped to minimum limit. Governor is connected in air lines as shown in Air Line Diagrams in Air Brakes (Sec. 4B of this manual).

GOVERNOR OPERATION (Fig. 9)

1. When air pressure in system is less than maximum for which governor is set, tube (1) holds lower valve (12) against bottom seat. In this position upper valve (13) is open, thus leaving unloader line (8) open to atmosphere through exhaust port (6).

2. When air pressure in system exceeds maximum for which governor is set, tube (1) pulls valve (13) up off valve (12) and, with aid of spring (11) and air pressure under lower valve (12), closes valve (13) against upper seat and opens lower valve. In this position exhaust port (6) is closed and air travels past valve (12) into unloader valve diaphragm cavity, opening unloader valves.

GOVERNOR ADJUSTMENT (Fig. 9)

1. Pressure range (that is, the difference between the pressure at which governor causes compressor unloader valves to open or close) may be adjusted by adding or removing shims (7) under valve stem guide (5). Removing shims will increase range; adding shims will decrease range. Changing shims at this point changes the pressure range but does not affect the "Set" or maximum pressure.

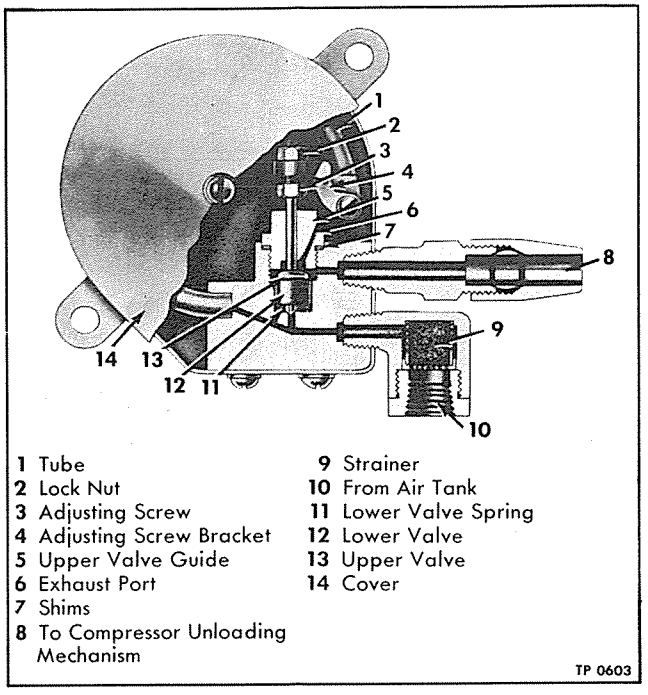


Figure 9—Air Compressor Governor

2. Set pressure (that is pressure at which governor will cause compressor unloader valves to open) may be adjusted as follows:

a. Hold adjusting screw (3) with wrench and loosen adjusting screw lock nut (2).

b. To increase set pressure, turn screw (3) clockwise; to lower set pressure, turn screw counterclockwise.

c. Hold adjusting screw (3) with wrench and tighten adjusting screw lock nut (2).

d. Recheck pressure at which governor cuts in and out in accordance with "Specifications" at end of this section.

GOVERNOR TEST (Figs. 9 and 10)

Governor should be inspected and tested at regular intervals. Leakage and pressure tests described here will give an accurate check as to governor's condition. If governor does not meet all requirements, it should be cleaned, adjusted, repaired, or replaced with a reconditioned unit.

The governor may be tested either on the bench or in the vehicle. The hook-up for testing

AIR COMPRESSOR

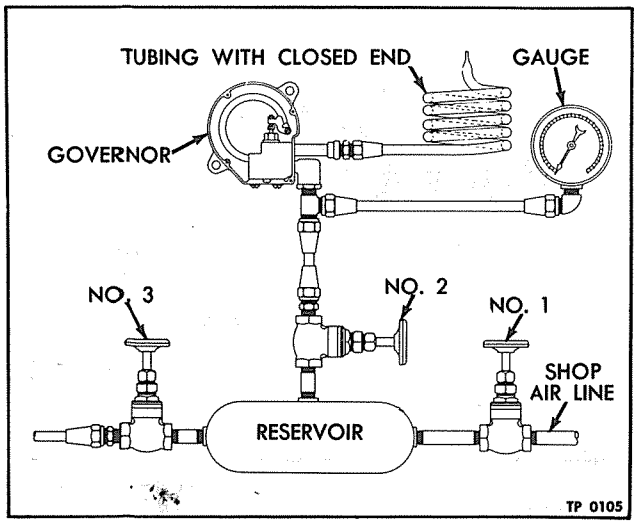


Figure 10—Governor Test Hook-up

on bench is shown in figure 10 and the procedure is as follows:

1. Connect governor as shown in figure 10 with all air cocks closed. Remove cover from governor.

2. Open air cock (1), charging reservoir to full line pressure.

3. Crack air cock (2) and note pressure on gauge when governor cuts out.

4. While governor is in cut-out position, apply soap suds to exhaust port (6). If leakage is sufficient to cause more than a 3-inch diameter bubble in three seconds, upper valve should be reseated.

5. Close air cock (1) and crack cock (3), releasing pressure slowly. Note pressure at which governor cuts in and close cock (3) immediately to retain pressure on governor in cut-in position. Apply soap suds to test lower valve leakage.

The governor may be tested in the vehicle by following a procedure similar to that used for bench testing. First build up pressure to cause governor to cut out and observe pressure. Apply soap suds to exhaust port to check upper valve leakage. Second, reduce pressure slowly and note pressure at which governor cuts in. Apply soap suds to check lower valve leakage.

GOVERNOR DISASSEMBLY (Fig. 9)

1. Remove cover (14) from governor case by removing screw from center of cover.

2. Remove tubing connector and air strainer from governor body. Remove four screws and lock washers located at bottom of case and remove governor from case.

3. Remove screw attaching adjusting screw bracket (4) to end of tube (1) and remove adjusting screw (3) and bracket (4). Remove screw from bracket by removing lock nut (2), then unscrewing adjusting screw from bracket.

4. Unscrew upper valve guide (5) from governor body and remove guide and upper valve (13). Remove upper valve (13) from guide (5).

5. Lift shims (7) out of governor body, then invert body and shake out lower valve (12) and spring (11).

6. Disassemble air strainer (9) by unscrewing cap nut from air strainer body and removing cup screen, lamb's wool, and cylindrical screen from strainer body.

CLEANING AND INSPECTION

1. Clean all parts in a suitable cleaning fluid. Be particularly sure that all passages through the governor body are clean and not obstructed in any way. Also make sure small drilled passage in lower valve is clean and open. Lamb's wool in air strainer may be used again if it can be washed clean in cleaning fluid, other wise it must be replaced.

2. Carefully examine tube for cracks, dents, or other damage. If damaged in any way, or if it has become loose at the soldered joint at the governor body, the body and tube assembly must be replaced.

3. Inspect seat on upper valve and upper valve guide for wear or damage. Also check fit of upper valve stem in upper valve guide. If the seat on the upper valve shows a decided groove from wear, or if the upper valve stem is not a neat sliding fit in the upper valve guide, the upper valve and valve guide must be replaced as an assembly.

4. Inspect lower valve for wear or damage. If the valve is grooved excessively, it must be replaced. Check fit of lower valve in governor body. It must be a neat sliding fit. If clearance is excessive, lower valve must be replaced.

GOVERNOR REPAIR

1. If the upper valve and seat are not too badly worn, they may be repaired by carefully grinding the valve to its seat using valve grinding tool (BWE-211398) and grade 1000 grinding compound. To grind valve, temporarily install upper valve in upper valve guide and screw guide into body. Valve must be turned back and forth during the grinding operation using a piece of cord in manner illustrated in figure 11. The cord should be pulled in such a manner as to keep the upper valve contacting the valve seat on the valve guide during the grinding operation. Clean valve and seat thoroughly with cleaning fluid after grinding.

2. If lower valve is not worn excessively, it may be ground to its seat using grinding tool (BWE-221609) and grade 1000 grinding compound.

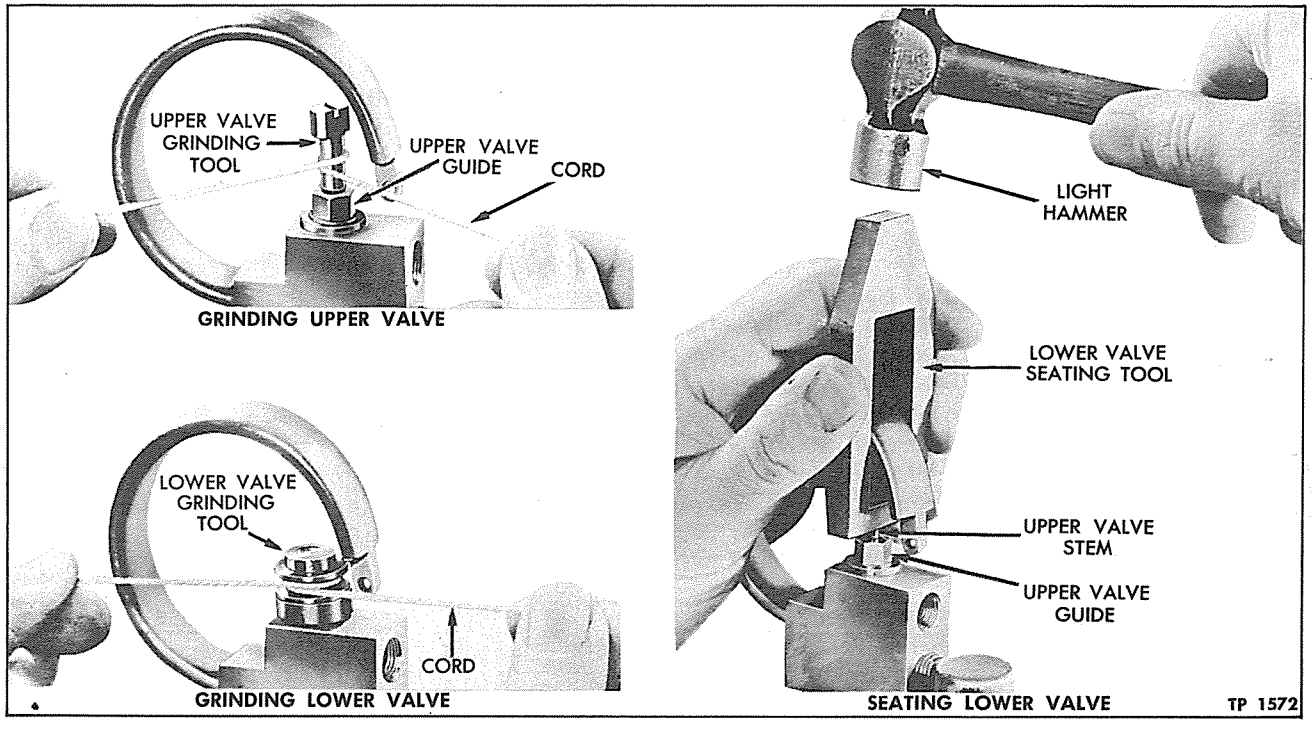


Figure 11—Grinding and Seating Governor Valves

To grind valve, insert valve in body, then thread grinding tool into body. Turn valve back and forth using cord in manner illustrated in figure 11. A slight downward pull must be exerted on cord during grinding operation.

3. If a new lower valve is being installed, tapping the valve to its seat before grinding is usually helpful. To do this, place lower valve in governor body, then install upper valve and upper valve guide in body. Then, using seating tool (BWE-211397) and a light hammer, lightly tap valve to its seat a few times. Grind valve to its seat as directed in step 2 above. Thoroughly clean valve and governor body in cleaning fluid after grinding. If lower valve leakage cannot be corrected by the above procedure, the complete governor must be replaced.

GOVERNOR ASSEMBLY (Fig. 9)

1. Extreme cleanliness of bench, hands, tools, and governor parts is important.

2. Install lower valve spring (11) and lower valve (12) in recess in governor body. Install shims (7) in body, being sure to use same thickness of shims as were removed.

3. Insert upper valve stem (13) through upper valve guide (5) and thread upper valve guide into body. Tighten guide firmly.

4. Install adjusting screw (3) and lock nut (2) in adjusting screw bracket (4) and install bracket on end of tube (1). Tighten screw attaching bracket to tube firmly.

5. Pack cylindrical strainer with new or cleaned lamb's wool and place screen in strainer body. Place cup strainer screen over end of cylindrical screen in strainer body, then install cap nut in strainer body. Thread strainer assembly into lower opening in governor body.

6. Adjust governor as previously directed under "Adjustment," and test as previously directed under "Tests" in this section.

7. If governor passes all tests, remove strainer and install governor assembly in case. Attach with four screws and lock washers. Install cover on case and attach with screw and lock washer.

8. Thread air strainer into lower opening in governor body and tube connection into upper opening. Tighten firmly, with air strainer positioned as shown in figure 9. Plug both openings against entrance of dirt during installation.

AIR COMPRESSOR

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however, are not supplied by GMC Truck & Coach Division. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

Vendor No.	Tool Name	Vendor Code
BWE-202812	Unloader and Discharge Valve Grinding Tool	BWE
BWE-230197	Driver Bit for Valve Grinding Tool	BWE
BWE-213606	Unloader Valve Seat Reamer	BWE
BWE-230194	Discharge Valve Seat Lapping Disk	BWE
BWE-221622	Discharge Valve Seat Lapping Stone	BWE
BWE-221614	Discharge Valve Seat Reamer	BWE
BWE-211398	Governor Upper Valve Grinding Tool	BWE
BWE-221609	Governor Lower Valve Grinding Tool	BWE
BWE-211397	Governor Lower Valve Seating Tool	BWE

Vendor Code	Vendor Name	Address
BWE	Bendix-Westinghouse Automotive Air Brake Company	Elyria, Ohio

SPECIFICATIONS

AIR COMPRESSOR

Make ..... Bendix-Westinghouse
Model 2-UE-7-1/4-FW
Capacity ..... 7-1/4 cu. ft. per min.
Unloading Valve Clearance ..... .010"-.015"
Unloading Valve Springs
  Free Height ..... 1-3/64"
  Height under load of 5.4-6.6 lb. ..... 3/4"
Unloading Valve Lever Spring
  Free Height ..... 27/32"
  Height Under Load of 7.7-8.7 lb. ..... 5/8"
Unloading Valve Stems -
  Maximum Allowable Wear ..... .002"
Discharge Valve Seats -
  Worn Groove Not to Exceed ..... .003"
Piston Ring Gap (in Cylinder) ..... .010"-.015"
Piston Ring Clearance in Groove ..... .0015"-.0025"
Clearance between Piston and
  Cylinder Wall ..... .002"-.004"
Connecting Rod Clearance
  Radial ..... Not to Exceed .002"
  Side ..... .006"-.015"
Crankshaft-Maximum Allowable
  Out-of-round ..... .001"
Cover to Crankshaft Seal
  Ring Gap (Installed) ..... .008"-.015"
Cylinder Bores
  Maximum Allowable Out-of-round ..... .003"
  Maximum Allowable Taper ..... .003"

AIR COMPRESSOR GOVERNOR

Make ..... Bendix-Westinghouse
Model 0-1
Cut-out Pressure ..... 100-105 lb.
Cut-in Pressure ..... 80-85 lb.
Pressure Range ..... 15-25 lb.

Hand Brake

Contents of This Section

Related Subjects in Other Sections

4

Hand brake is two-shoe, external contracting type, mounted at output shaft on transmission. Brake shoes act on outside of brake drum, which is bolted to transmission output shaft companion flange. Brake shoes are actuated through rods and levers by hand brake lever, located at left of driver.

One-piece block type lining is bolted to each shoe. Bolt holes in lining are counterbored to permit maximum amount of wear on linings before bolt heads are in danger of scoring brake drum.

Lower ends of shoes are mounted on an eccentric anchor pin which provides a means of equalizing lining to drum clearance at lower ends of both shoes. Anchor pin is held in position in anchor bracket by two clamp bolts. Anchor pin is drilled and threaded for lubrication fitting. Anchor pin ends of brake shoes are equipped with replaceable bushings.

Upper ends of brake shoes are held in place by the adjusting screw which is inserted through both shoes and the locating bracket. Adjusting nuts and springs on adjusting screw provide independent adjustment for upper end of each shoe. Adjusting pin holes in brake shoe are equipped with replaceable bushings.

HAND BRAKE ADJUSTMENT

INITIAL ADJUSTMENT (Fig. 1)

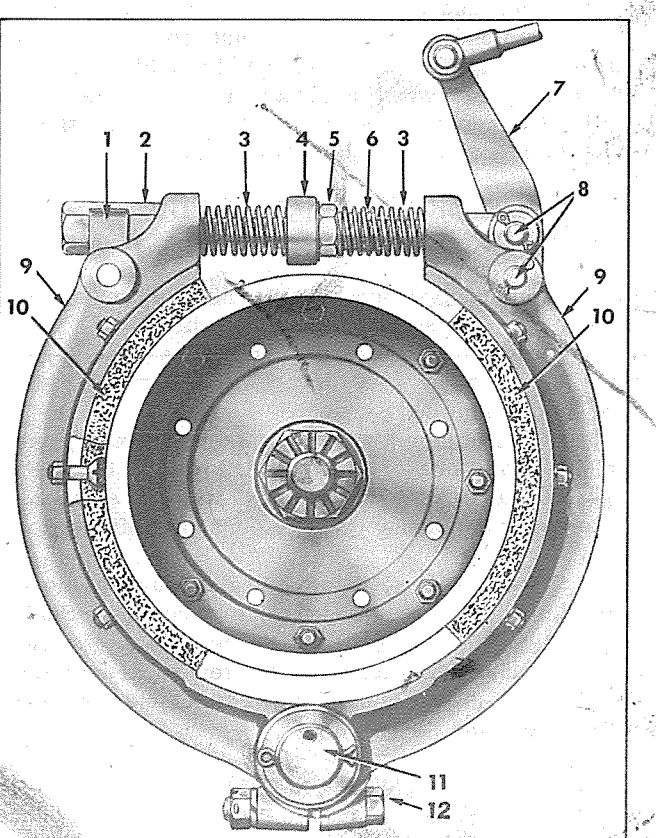
This adjustment is necessary when the brake shoes have been relined or replaced, or when the anchor pin has been removed from its original setting.

1. Remove two screws attaching brake shield to locating bracket and remove shield.

2. Place hand brake lever in fully released position.

3. Remove cotter pins and loosen nuts on clamp bolts in anchor bracket.

4. Turn anchor pin as necessary to equalize clearance between brake drum and lower end of lining on each shoe. Tighten clamp bolts in anchor



1 Adjusting Nut Spring	8 Lever Pins
2 Outer Adjusting Nut	9 Brake Shoe
3 Springs	10 Brake Shoe Lining
4 Locating Bracket	11 Anchor Pin
5 Inner Adjusting Nut	12 Anchor Bracket Clamp Bolt
6 Check Nut	
7 Lever	

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Figure 1—Hand Brake Installed

HAND BRAKE

bracket and secure with new cotter pins.

5. Adjust upper end of lining to drum clearance as directed below under "Adjustment for Wear."

ADJUSTMENT FOR WEAR (Fig. 1)

This adjustment is to compensate for normal wear. Need of adjustment is indicated when the hand brake lever reserve travel is less than one-half the ratchet range.

Before making this adjustment, check for equal clearance between brake drum and lower end of lining on each shoe. If clearance is not the same for both shoes, make "Initial Adjustment" previously described.

1. Remove two screws attaching brake shield to locating bracket and remove shield.
2. Place hand brake lever in fully released position.
3. Loosen inner adjusting nut check nut.
4. Turn inner and outer adjusting nuts as necessary to obtain .030'' to .040'' clearance between upper end of each lining and brake drum.
5. Tighten inner adjusting nut check nut and make sure outer adjusting nut is held in place by lock spring when adjustment is completed.
6. Position brake shield on top of brake shoes and attach to locating bracket with two screws.

BRAKE SHOE AND DRUM REMOVAL (Fig. 1)

1. Remove two screws attaching brake shield to locating bracket and remove shield.
2. Remove cotter pins from brake shoe lever pins and remove pins attaching lever to brake shoe and adjusting screw.
3. Remove adjusting screw, adjusting nuts, and springs from brake shoes and locating bracket.
4. Remove cotter pin and washer securing brake shoes on anchor pin. Slide shoes off anchor pin.
5. If necessary to remove brake drum, remove propeller shaft as directed in Propeller Shaft (Sec. 18 of this manual), then remove bolts attaching brake drum and oil slinger to transmission output shaft companion flange and remove oil slinger and brake drum.

INSPECTION

1. Inspect brake lining and replace if worn down close to bolt heads. Make sure new lining fits firmly against shoe.
2. Examine anchor pin bushings in lower ends of shoes and examine brake shoe pin bushings in upper end for wear. Replace bushings if worn excessively. Burnish bushings after installation to dimensions listed in "Specifications" at end of this section.
3. Check anchor pin for wear and replace if necessary. Make sure lubricant passages in anchor pin are not clogged.
4. Examine braking surface of drum for scoring or roughness. Replace if scored or otherwise damaged.

BRAKE DRUM AND SHOE INSTALLATION (Fig. 1)

1. If brake drum was removed, make sure mating surfaces of drum and transmission output shaft companion flange are clean and smooth.
2. Position brake drum on output shaft flange, making sure the outer circumference of the flange enters the counterbore in the brake drum web. Position oil slinger in drum, then install and tighten bolts attaching oil slinger and brake drum to output shaft flange.
3. Install propeller shaft as directed in Propeller Shaft (Sec. 18 of this manual).
4. Position brake shoes on anchor pin and secure in place with washer and cotter pin.
5. Install adjusting screw through brake shoes and locating bracket, with springs and adjusting nuts in place as shown in figure 1.
6. Position brake shoe lever on upper end of brake shoe, install brake shoe pins, and secure in place with cotter pin.
7. Lubricate anchor pin as directed in Lubrication (Sec. 13 of this manual). Lubricate brake shoe pins with oil can.
8. Adjust hand brake as previously directed under "Hand Brake Adjustment" in this section.

SPECIFICATIONS

Type	Two-shoe external contracting
Drum Diameter (Outside)	11"
Brake Shoe Lining	
Width	6"
Thickness	5/8"
Brake Shoe Anchor Pin Bushings	
I.D. (Burnish after assembly)	1.7525"-1.7505"
O.D.	Press fit in shoe
Length	1-15/64" +0 -1/64"
Dia. of holes in shoe	1.8755"-1.8735"
Brake Shoe Lever Pin Bushings	
I.D. (Burnish after assembly)	0.6265"-0.6245"
O.D.	Press fit in shoe
Length	1-3/64" +0 -1/64"
Dia. of holes in shoe	0.7505"-0.7485"
Anchor Pin	
Diameter (at bushings)	1.748"-1.746"
Length (overall)	11-1/4"
Brake Shoe Lever Pin	
Diameter	0.625"-0.623"
Length	4-1/4"

Clutch

Contents of This Section

Related Subjects in Other Sections

Clutch (fig. 1) is single plate dry disc type, manually controlled (disengaged and engaged) by foot-operated pedal and linkage (fig. 2).

Clutch disc assembly (driven member) is splined to transmission main drive gear. Two facings are riveted to driven disc and these facings are held tightly between friction surface on pressure plate and flywheel plate when clutch is engaged.

OPERATION

(Key Numbers in Text Refer to Fig. 1)

When clutch is in engaged position, springs (34) exert force against pressure plate (10) clamping driven disc assembly (4) against flywheel clutch plate (5). Crankshaft (1) is thus connected to transmission by driven disc assembly (4) and transmission main drive gear (32).

When clutch is disengaged, release yoke (29) operated by pedal, moves release sleeve (28) which forces release bearing (31) against inner ends of levers (22). Resultant force at outer ends of levers (22), which are pivoted on pins (13) and (17) in the pressure plate and adjusting yoke, overcomes the force exerted by clutch springs (34) and retracts pressure plate (10), thus releasing clutch.

CLUTCH ADJUSTMENTS

Two adjustments are provided - free-travel and finger and thrust button clearance.

FREE TRAVEL

Adjustment for pedal free-travel by means of adjusting nut (hand wheel), located in engine compartment which sets clutch pedal travel before release bearing contacts release lever thrust buttons. This adjustment is required when installing new clutch, installing new facings, or adjusting for normal facing wear.

LEVER THRUST BUTTON POSITION

Adjustment for proper dimension between release lever thrust buttons and outer face of clutch cover is required only when assembling clutch to flywheel. This adjustment is covered in clutch assembly operations.

PEDAL FREE-TRAVEL ADJUSTMENT

(Key Numbers in Text Refer to Fig. 1)

Need of adjustment for pedal free-travel (defined as the first easy movement of clutch pedal) is indicated when pedal free-travel is less than limits listed in "Specifications" at end of this section. Adjustment for pedal free-travel is made at clutch linkage (fig. 2). As clutch facings wear, release levers (22) move toward release bearing (31) reducing clearance between the two. This reduced clearance results in a reduction of pedal free-travel, which if not corrected by resetting to specified limits, will result in excessive wear to clutch facings. Therefore, it is necessary to adjust linkage periodically to provide proper pedal free-travel and assure complete clutch engagement.

1. Turn adjusting nut (hand wheel) (fig. 2) to provide 1-1/2" clutch pedal free-travel before clutch starts to release.

NOTE: Pedal free-travel must be checked with hand on pedal and not foot as this adjustment is very sensitive.

2. Make periodical inspection of clutch mechanism through inspection hole in bottom of clutch

CLUTCH

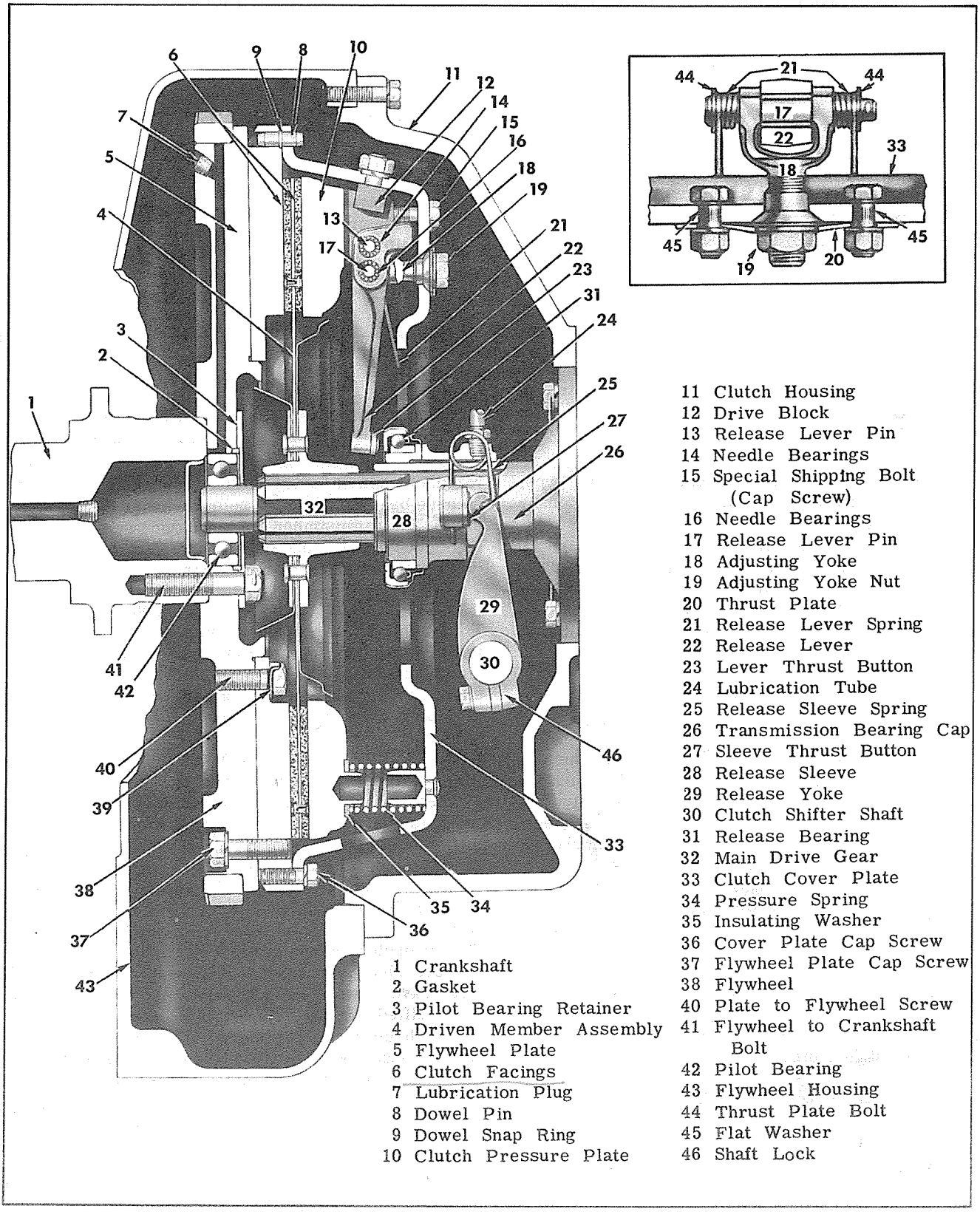


Figure 1—Sectional View of Clutch Assembly

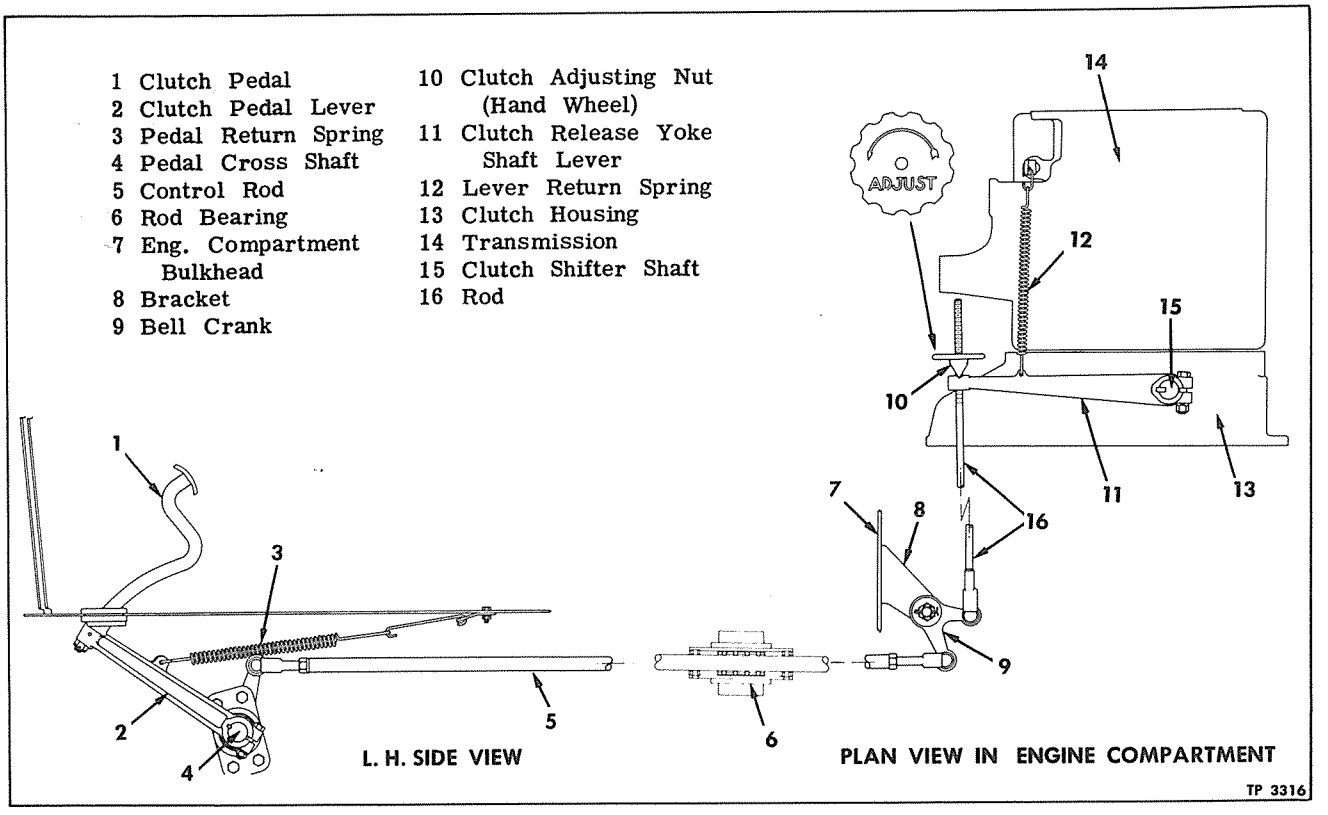


Figure 2—Clutch Control Linkage

housing. When clutch levers near the edge of inner rim of cover the clutch disc facings should be replaced.

CLUTCH REMOVAL

(Key Numbers in Text Refer to Figure 1)

Before removing clutch, transmission must be removed as instructed in Transmission (Sec. 17 of this manual). Then proceed as follows:

1. Install six special cap screws (3/8"-16 x 1-1/2", threaded 1 inch) through holes in cover plate (33) located directly above each release lever. Turn screws into pressure plate (10) as far as possible. This procedure relieves pressure spring (34) load so cap screws (36) can be easily removed.

2. Install aligning arbor (CS-1182) or old clutch shaft to support driven disc when removing clutch.

3. Remove cover bolts (36), meanwhile supporting clutch to prevent distortion of clutch dowels (8). Tap flange of clutch cover with soft mallet to free clutch. Remove clutch assembly and driven disc.

4. Remove bolts (41) bearing retainer (3) and gasket (2) retaining pilot bearing in flywheel. Remove pilot bearing (42) using tool (CS-1914) shown in figure 3. Spread puller prongs in bearing by tightening thumb screw, then slide weight on puller against stop nut to pull bearing.

CAUTION: Use puller carefully as flywheel is not bolted to crankshaft during bearing removal.

RELEASE MECHANISM REMOVAL (Fig. 4)

1. Remove hair pin springs connecting release bearing sleeve to release yoke. Disconnect lubrication tube from release bearing sleeve, then slide bearing and sleeve assembly off end of transmission cap.

2. Remove cap screws from release yoke and withdraw clutch shifter shaft from clutch housing.

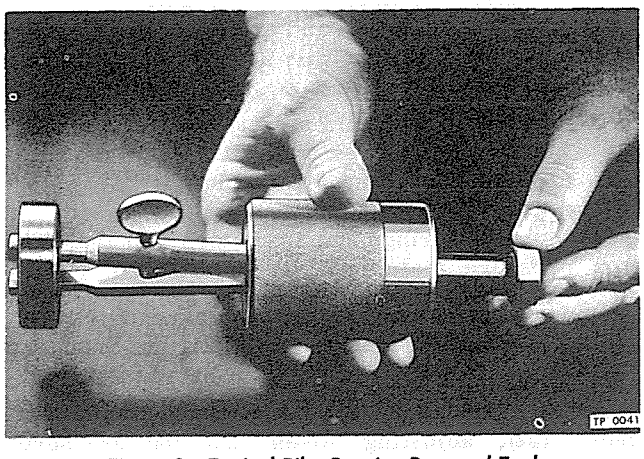
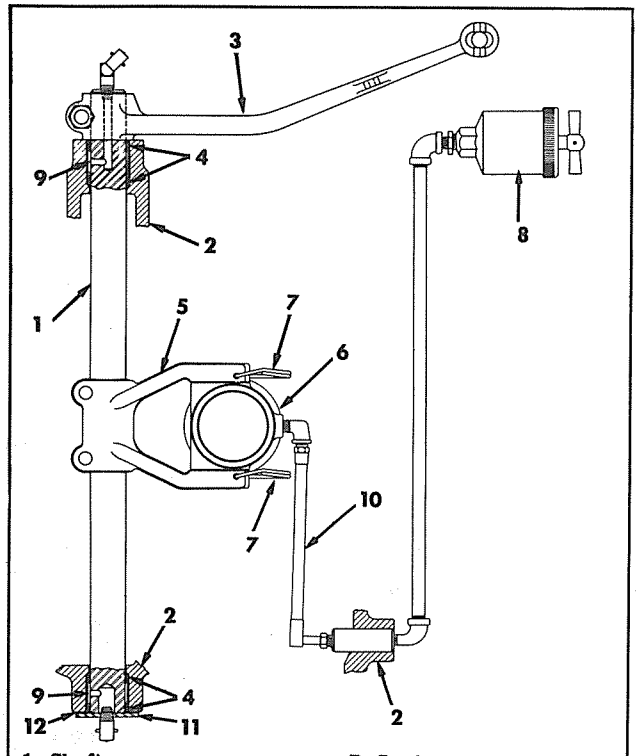


Figure 3—Typical Pilot Bearing Removal Tool

CLUTCH



1 Shaft	7 Spring
2 Clutch Housing	8 Grease Cup
3 Lever	9 Shaft Needle Bearing
4 Felt Seal	10 Tube
5 Yoke	11 Shaft Cover
6 Release Bearing and Sleeve Assembly	12 Shims

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Figure 4—Clutch Release Mechanism

CLUTCH DISASSEMBLY (Fig. 1)

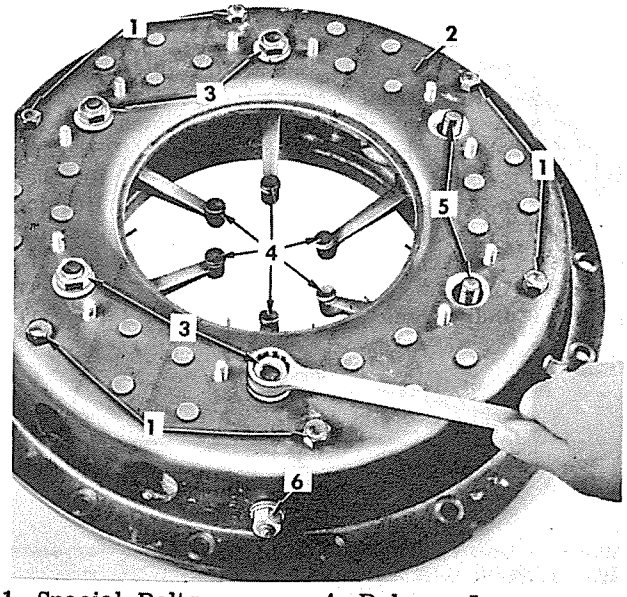
1. Remove nuts, washers, and thrust plate (20) used to lock each adjusting nut (19).

2. Remove adjusting nuts (fig. 5) from yokes. Special bolts will hold springs in compressed position while removing adjusting nuts.

3. Mark cover (33) and pressure plate (10) so that relative position will be known when reassembling; then remove six special cap screws (15), turning screws alternately and in gradual stages until spring pressure between cover and plate has been relieved. Lift clutch cover (33) off the pressure plate assembly.

4. Remove springs and insulators (34) and (35) from pressure plate bosses.

5. Remove cotter pins from release lever pins (13 and 17) and pull out pins. Be careful to note position of washers (45), springs (21) and number of rollers (14 and 16) so parts can be reassembled correctly. This completes disassembly of release levers (22), adjusting yokes (18) and pressure plate (10).



1 Special Bolts	4 Release Levers
2 Clutch Cover	5 Release Lever Yoke
3 Yoke Adjusting Nuts	6 Driving Block Nut

TP 2910

Figure 5—Yoke Adjusting Nut Removal

INSPECTION

Prior to inspection, wash clutch parts (except driven disc facings) in clean gasoline or cleaning fluid. Refer to "Specifications" at end of this section for all clearances.

1. Inspect driven disc assembly for worn, loose or oil-soaked facings; for loose rivets at hub; for distortion. If disc is distorted, new driven disc and facings assembly should be used. DO NOT ATTEMPT TO RELINE DISTORTED DISC. Refer to "Specifications" at end of this section.

2. To inspect release bearing, first soak in gasoline or cleaning solvent, tap sharply on wood block to dislodge dirt particles, flush in gasoline or cleaning solvent and blow dry by directing air at right angle to bearing, revolving slowly by hand. Examine bearing for pits and scores and, if usable, dip in clean oil. Do not disassemble bearings.

3. Inspect pressure plate and flywheel plate for checks and scores on contact surface. For refacing of pressure plate, see "Refacing Clutch Pressure Plate" under "Repair" later in this section. Flywheel plate can be refaced in similar manner.

4. Check clearance between driving blocks and slotted lugs in pressure plate. If there is indication of wear or scoring on driving blocks, loosen nuts and turn all six blocks 90 degrees, using other two sides for bearing contact.

5. Clean and inspect rollers used at release lever pins. Replace if rollers show wear.

6. If hardened buttons (23) in end of levers (22) show wear, they can be removed readily and new buttons installed. It is not necessary to remove levers from pressure plate to replace buttons.

7. Check pressure springs for proper load.

8. Check spline clearance of transmission drive shaft and driven disc hub.

9. Clean and inspect pilot bearing. Replace if bearing shows wear.

10. If new clutch housing is to be installed or if any clutch parts show undue wear traceable to misalignment, the following check is recommended:

a. Check concentricity of clutch housing pilot flange with clutch housing pilot hole.

b. Check clutch housing rear face for squareness with crankshaft.

11. Inspect release yoke shaft bushings in clutch housing. Also note condition of shifter shaft at points contacted by bushings. Replace bushings and shaft if worn or scored.

REPAIR

CLUTCH DRIVEN DISC AND FACINGS

In normal service, clutch facings wear evenly and last for a long time, provided clutch pedal is kept in proper adjustment.

To replace facing, drill out facing rivets from head or smooth side of rivet. Use drill slightly smaller than rivet diameter. Rivet will turn if drilled from other side.

Support assembly during facing removal and installation to prevent distortion of disc.

DO NOT USE BRAKE RELINING MACHINE TO REMOVE RIVETS AS CLUTCH DISC WILL BE SPRUNG OR DISTORTED.

Facings are interchangeable. When installing new facings, use genuine rivets and facings listed in GMC Parts Book.

Alternate rivets so that heads are in opposite directions as shown in figure 6.

Check over-all thickness of assembly after facings are installed. Test assembly for run-out. Disc should run true within limits given in "Specifications" at end of this section.

PRESSURE PLATE AND
FLYWHEEL CLUTCH PLATE

Either the pressure plate (10, fig. 1), or the flywheel clutch plate (5, fig. 1), or both, if scored or checked, can be refaced. Refer to "Specifications" at end of this section for limits. Bear in mind that minimum thickness of each plate depends on whether both plates or only one are to be refaced. In either case grind off only enough metal to provide a new smooth, flat friction surface. If grinding equipment is not available, machine and then polish surface with emery.

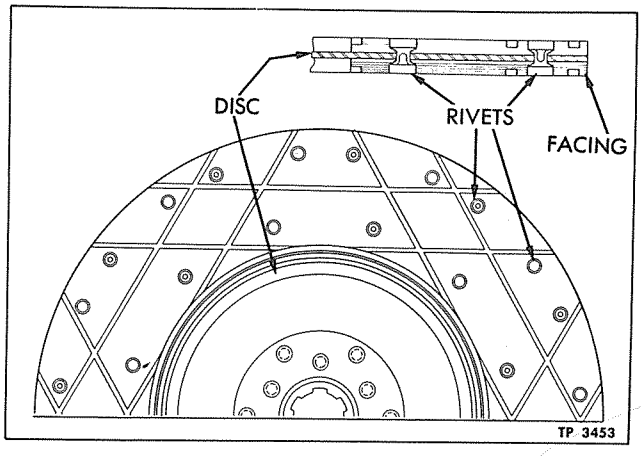


Figure 6—Clutch Disc Facing Rivet Pattern

Plates thinner than limits given may cause plate distortion and clutch drag. Also, plates which are too thin prevent full length thread engagement of adjusting nut (19, fig. 1) on adjusting levers (18, fig. 1). Place either plate face down on a surface plate and use surface gauge to check thickness. Measure height of pressure plate from surface plate to finished face of pressure spring seat. Be sure insulating washers have been removed.

For each 1/32" of material ground off from plates, a special washer 1/32" thick should be placed between each pressure spring insulating washer (35, fig. 1) and pressure plate boss as clutch is reassembled. The special washers maintain proper spring pressure by compensating for material ground off plate.

CLUTCH ASSEMBLY

(Key Numbers in Text Refer to Fig. 1)

1. Assemble adjusting yokes (18) and springs on clutch release levers as follows:

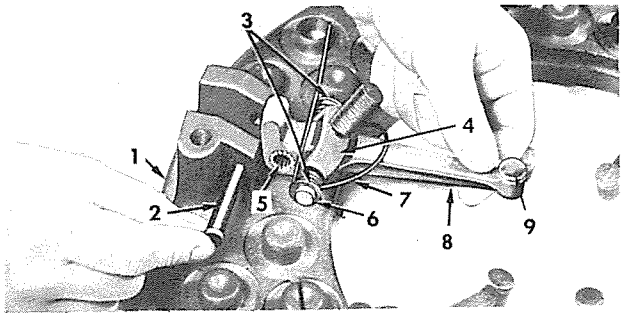
a. Make two pilot pins slightly shorter than needle rollers and same diameter as pins (13 and 17). Chamfer ends of pins.

b. Lay lever (22) on flat surface and insert a pilot pin in each hole. Apply light coat of release bearing lubricant on needle rollers referring to Lubrication (Sec. 13 of this manual) for correct lubricant. Insert rollers (14 and 16) around pilot pins, then put adjusting yoke (18) in position with spring (21) straddling yoke. Place flat washer (45) on pin (17) then push pin through spring yoke and lever, thereby pushing out pilot pin. Assemble washer (15) and cotter pin to retain pin (17).

c. Position lever and yoke assembly at pressure plate, then install pin (fig. 7) and retain with cotter pin.

d. Repeat procedure described in steps b. and

CLUTCH



1 Pressure Plate
2 Lever to Pressure Plate Pin
3 Flat Washer
4 Yoke
5 Bearing Rollers
6 Yoke to Lever Pin
7 Lever Spring
8 Release Lever
9 Release Lever Button

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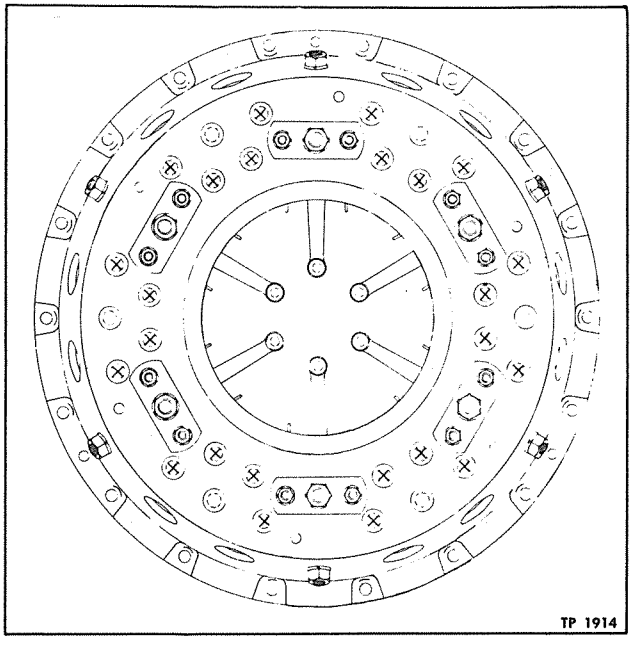
Figure 7—Assembling Clutch Release Lever to Pressure Plate

c. above to assemble each lever to pressure plate.

2. Place pressure plate and levers assembly face downward on bench. If the pressure plate or flywheel plate has been resurfaced, place 1/32 inch shims between insulating washers (35) and spring bosses on pressure plate. Use one shim for each 1/32 inch of material removed during resurfacing operations. Refer to figure 8 for proper position of springs on pressure plate.

3. When insulating washers (35) and springs (34) are in position, set cover (33) over springs (34) fitting each spring guide on cover into corresponding spring. Cover must assume original position in relation to pressure plate. Refer to alignment marks made at disassembly to determine correct position. Drive blocks (12) must enter slots in pressure plate.



TP 1914

Figure 8—Location of Pressure Springs on Pressure Plate Locate Springs as Indicated by "X's."

4. Install six special cap screws (fig. 10) through holes in cover plate, starting each screw into tapped hole in pressure plate, then tighten special screws alternately and in gradual stages to compress springs (34) and bring threaded ends of yokes (18) into respective holes in cover plate. A pointed rod may be used to guide yokes through holes as cap screws are tightened. See that ends of springs (21) do not catch on under side of cover as special screws are tightened.

5. Thread adjusting nuts (19) onto yokes (18) so that end of yoke is approximately flush with top of nut.

6. Install adjusting nut thrust plates (20), tightening plate retaining nuts firmly.

7. Clutch assembly is now completely built up and ready to be assembled to flywheel. Special cap screws should remain in place until cover to flywheel screws have all been installed, then they must be removed to allow clutch springs (34) to operate.

CLUTCH INSTALLATION

RELEASE MECHANISM INSTALLATION (Fig. 4)

1. Hold clutch release yoke (5) in position in clutch housing (2), then insert shifter shaft (1) down through upper needle bearing assembly (9) through yoke (5), and into lower bearing.

2. Install clamp bolts and locks which locate yoke (5) on shifter shaft (1).

3. Install clutch release bearing and sleeve assembly (6) on transmission drive gear cap and connect lubrication tube (10). Install springs (7) which clip sleeve to yoke.

4. Install lever (3) on upper end of shaft (1).

5. Check action of shifter shaft to ascertain if binding exists between yoke and release bearing sleeve. If these two parts touch at either upper or lower side of sleeve, loosen yoke clamp bolts and try driving yoke up or down as necessary to give equal clearance above and below sleeve. If proper clearance cannot be obtained by above procedure, remove cover (11) and shims (12) at lower end of shaft (1) and vary the shim pack as necessary to obtain proper clearance between yoke and sleeve.

6. Lubricate bearings (9) through fittings and turn down grease cup to force lubricant into release bearing (6).

PILOT BEARING INSTALLATION

1. Hand pack pilot bearing (42) with lubricant as specified in "Lubrication" section. Then carefully drive bearing part way into flywheel (38) using tool (K-410) as shown in figure 9. As-

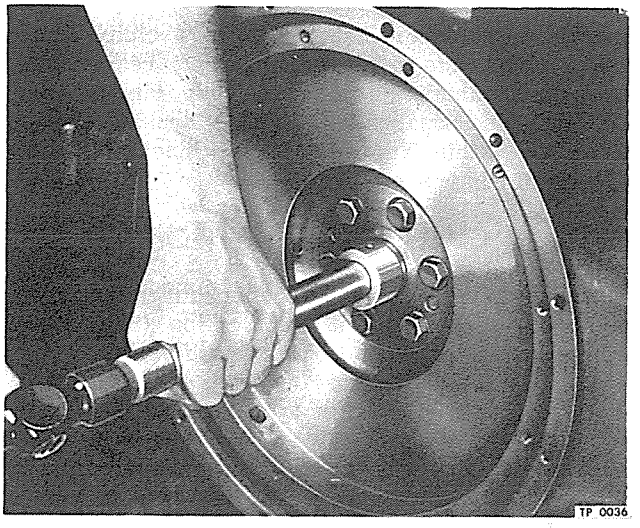


Figure 9—Typical Pilot Bearing Replacing Tool

semble gasket (2), bearing retainer (3) and flywheel bolts (41). Tighten flywheel bolts securely which will press pilot bearing to proper depth in flywheel and at the same time solidly attach flywheel (38) to crankshaft (1). Install lockwire. Pilot bearing should not be bottomed in flywheel as this will prevent grease entering at rear side of bearing.

COVER PLATE & DRIVEN DISC INSTALLATION

1. Put driven disc (4) in place against flywheel (38) with short end of splined hub toward flywheel. Use aligning arbor (CS-1182) or old clutch shaft to hold assembly in position.

2. Place clutch assembly in position against flywheel and install cap screws (36) using new lock washers. Tighten screws securely.

3. Remove special cap screws (fig. 10) previously installed to facilitate clutch installation. These screws must be removed before clutch will engage.

4. Adjust nuts (19) on yokes (18) so that contact points of release levers (22) are within dimensional limits when measured from straight edge laid across outer face of clutch cover (33).

A closer adjustment may be obtained by using an adjusting tool (CS-1420) such as illustrated in figure 11. "Specifications" at end of this section apply when new driven disc and facings assembly of specified thickness is used.

Use tool in the following manner:

a. With gauge pin flush with outer end of sleeve, thread adjusting sleeve in or out as necessary to obtain the dimension as shown in figure 11. Lock sleeve in position with lock nut.

b. Position tool on clutch cover plate as shown with center of adjusting sleeve in line with center of clutch release lever button; then adjust stop pins until snug against inner edge of clutch cover.

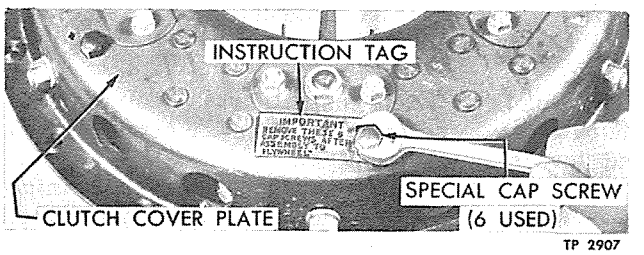


Figure 10—Clutch Instruction Tag and Special Bolts

c. Adjust release lever by turning release lever adjusting nut in or out until lever button contacts gauge pin. With lever button just contacting gauge pin, outer end of pin must be flush with sleeve or extend not more than notch (0.030").

NOTE: Setting of release levers in relation to outer face of clutch cover is very important and must be held within limits in order to assure proper clutch action without drag.

5. Install transmission as instructed in Transmission (Sec. 17 of this manual).

6. Adjust clutch controls as instructed in "Clutch Adjustments" previously in this section.

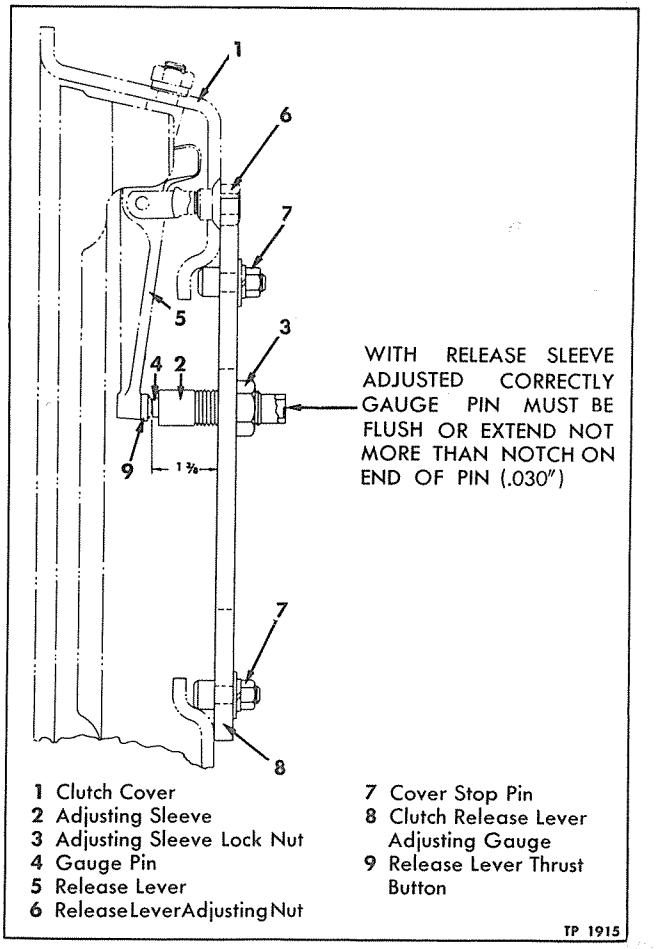


Figure 11 —Clutch Release Lever Adjusting Tool

CLUTCH

CLUTCH CONTROLS

(Key Numbers in Text Refer to Fig. 2)

Clutch is manually controlled by foot-operated clutch pedal, interconnected to power plant by rods and levers.

Clutch pedal (1) is installed on lever (2) which is mounted with Woodruff key on outer end of cross-shaft (4). Clutch cross shaft is supported in brackets which are equipped with needle bearings. Movement of clutch pedal is transmitted to bell crank (9) at engine compartment bulkhead through rods which slide through bearing assemblies (6).

Rod which connects bell crank (9) with shifter shaft lever (11) is threaded and has hand wheel (10) installed, which provides means for adjusting clutch pedal free-travel.

Spring (12) holds lever (11) against hand wheel so that tapered notch in lever prevents adjustment from changing.

CLUTCH HOUSING

Two dowel pins, held in clutch housing with snap rings, locate clutch housing on main transmission case. In production, clutch housing is bolted to main case with drive shaft bearing retainer in place. The dowel pin holes in both case and housing are then line reamed, and dowels installed. A finish cut is then taken on shoulder of clutch housing to align housing concentric with transmission mainshaft.

Service clutch housings are machined in same manner before shipment except that dowel pin holes are left under-sized. Bolt new clutch housing to main case as explained. Line ream dowel holes and install dowels and snap rings. Concentricity and squareness of clutch housing flanges should be within limits listed in "Specifications" at end of this section.

CLUTCH LUBRICATION

Lubrication intervals and recommended lubricants are specified in Lubrication (Sec. 13 of this manual). Lubrication points follow:

1. Clean release bearing in gasoline as it is not permanently lubricated type. Dip cleaned bearing in oil before reinstalling. Bearing should be lubricated thoroughly at installation and periodically thereafter by large grease cup attached to clutch housing.

2. Pilot bearing should be packed with lubricant at assembly. Additional lubricant should be supplied periodically through hole in flywheel.

Replace plug in flywheel with a standard lubrication fitting. Then reinstall plug in flywheel after lubricant has been added. Plug in flywheel is accessible through hole in flywheel housing. Turn flywheel as necessary to align plug with hole.

3. Clutch shaft splines should be lubricated at assembly.

4. Clutch release machanism should be lubricated at regular intervals.

5. Clutch shifter shaft bearings should be lubricated periodically through fittings located in upper end of shifter shaft, and plate at lower end of shaft.

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however, are not supplied by GMC Truck & Coach Division. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

Tool No.	Name	Code
CS-1420	Clutch Finger Adjusting Tool	CS
CS-1914	Pilot Bearing Remover	CS
CS-1182	Clutch Aligning Arbor	CS
K-410	Pilot Bearing Replacing Tool	KM

Code	Vendor Name	Address
CS	Curtiss and Smith Mfg. Co.	Pottstown, Penn.
KM	Kent-Moore Organization	Detroit, Michigan

SPECIFICATIONS

Type . . . . . Single Plate Dry Disc

Driven Disc and Facings
- Facings
  - Quantity 2
  - Outside Diameter . . . . . 16-3/4"
  - Inside Diameter . . . . . 10"
  - Thickness Each Facing . . . 0.184"-0.190"
- Disc and Facings - Total Thickness . . 0.457"
- Driven Disc Run-Out - Taken at 7-1/2" Radius On Flywheel Side . . . . . Not to Exceed 0.035"

Clutch Pressure Springs
- Type . . . . . Coil Compression
- Number Used 24
- Free Length . . . . . 2.843"
- Lbs. Pressure @ 1.950" . . 127-1/2 - 132-1/2

Release Lever Tension Spring
- Free Position . . . . . 45° from Horizontal
- Number Used 6

Clutch Pressure Plate
- Original Thickness . . . . . 1"
- Reface to Not Less Than . . . . . 29/32"

Flywheel Clutch Plate
- Original Thickness . . . . . 7/8"
- Reface to Not Less Than . . . . . 25/32"
- Outside Diameter . . . . . 19-3/8"
- Bore . . . . . 7.5005"-7.5015"
- Dowel Ream . . . . . 0.3732"-0.3739"

Clutch Release Bearing and Support
- Type . . . . . Ball

Clutch Pilot Bearing
- Type . . . . . Ball

Clutch Yoke and Shifter Shaft
- Clearance - Between Yoke and Release Bearing Support . . . . . Equal Both Sides
- Cross Shaft Diameter . . . . . 1.1250"-1.1235"

Clearance Between
- Cover Plate Drive Blocks and Pressure Plate . . . . . 0.008"-0.013"
- Driven Disc Hub and Trans. Main Shaft Spline . . . . . 0.095"-0.003"

Clutch Adjustment
- Pedal Free Travel (See Instructions). . 1-1/2"
- Release Levers to Face of Clutch Cover . . . . . 1-3/8"
- Levers in Same Plane Within . . . . . 0.030"

Transmission Clutch Housing Pilot Hole
- Run-Out Not to Exceed . . . . . 0.001"

Clutch Housing Pilot Flange Run-Out
- Not to Exceed . . . . . 0.002"

Clutch Housing Front and Rear
- Faces to Square with Crankshaft @ 7" Diameter Within . . . . . 0.005"

CLUTCH

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference - Make note of bulletin number in space below:

NOTES

Cooling System

Contents of This Section

Related Subjects in Other Sections

GENERAL

Cooling of engine is accomplished by means of a sealed cooling system (fig. 1) which utilizes a pressure valve located on the surge tank.

The valve maintains a slight pressure within the cooling system, when the engine is warmed up to normal operating temperature, thus raising the boiling point of the cooling liquid and reducing evaporation, which permits slightly higher engine operating temperature.

Surge tank, mounted as shown in figure 1, permits expansion of cooling liquid without loss from the system.

Economical operation of engine depends largely upon proper operating temperature being maintained. Adequate control of operating temperature during hot or cold weather is assured provided all units are properly maintained.

Cooling system preventive maintenance should be practiced. The problem of rust and corrosion damage should be eliminated by the prevention of formation of rust and corrosion rather than by the correction of rust clogged water passages through clean out methods or the replacement of damaged parts after cooling system is in trouble.

CIRCULATION (Refer to Figs. 1, 2, and 3)

Cooling liquid is drawn through radiator by water pump, force circulated through oil cooler and engine water jacket around cylinder bores, upward into cylinder head where cooling liquid circulates around exhaust valves and injectors, then back to radiator where it is cooled by action of fan.

1. Engine Warm-up Period. Thermostat, located in engine water outlet manifold, is closed and restricts flow of cooling liquid into radiator until minimum temperature (predetermined by calibration of thermostat) is reached. During this period circulation of cooling liquid is through engine, by-pass tube, and oil cooler. This arrangement directs warm water through the oil cooler, warming the lubricating oil, thus shortening the warm-up period.

2. Normal Operating Temperature. As cooling liquid nears normal operating temperature, thermostat opens gradually, permitting circulation through radiator as required to maintain proper operating temperature. As thermostat opens, permitting flow through radiator, pressure against by-pass valve, located at oil cooler water inlet, is reduced and by-pass valve spring closes valve, stopping flow through by-pass tube. This causes cooled water to flow through oil cooler thus cooling lubricating oil.

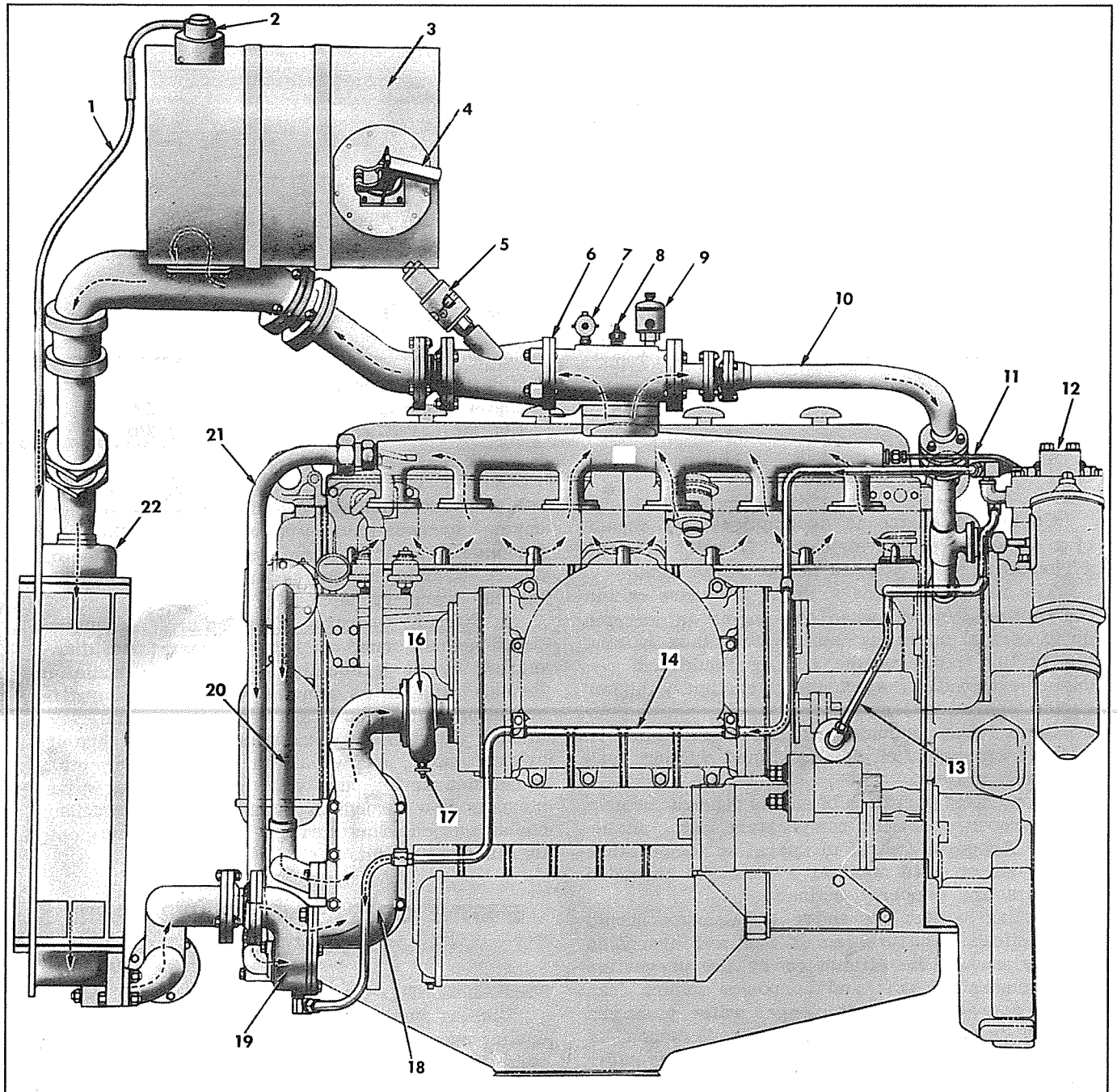
ENGINE OPERATING TEMPERATURE CONTROL

THERMOSTAT

Cooling system is designed to provide adequate cooling under the most adverse conditions; however, some device must be used to maintain operating temperature within a definite range and to prevent over-cooling during normal operation. This is accomplished by means of a thermostat in the engine water outlet to regulate the flow of the cooling liquid through the radiator.

Thermostat consists of a valve actuated by a thermostatic element and return spring. Valve starts to open at a predetermined temperature and continues to open gradually as temperature increases. Refer to "Specifications" at end of this section for operating temperature. Thermostat is not adjustable, its action being determined by the design of the element.

COOLING SYSTEM



1 Overflow Tube
2 Pressure Valve
3 Surge Tank
4 Radiator Filler
5 Radiator Shutter Thermostat
6 Thermostat Housing
7 Vent Cock
8 Temperature Gauge Engine Unit
9 Engine Overheat Thermostat
10 Heater Inlet Line
11 Air Compressor Vent Line
12 Air Compressor
13 Air Compressor Water Inlet Line
14 Air Compressor Water Outlet Line
15 Water Manifold
16 Water Pump
17 Drain Cock
18 Oil Cooler
19 By-Pass Valve Housing
20 Heater Return Line
21 Water By-Pass Tube
22 Radiator

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Figure 1—General Arrangement of Cooling System Units

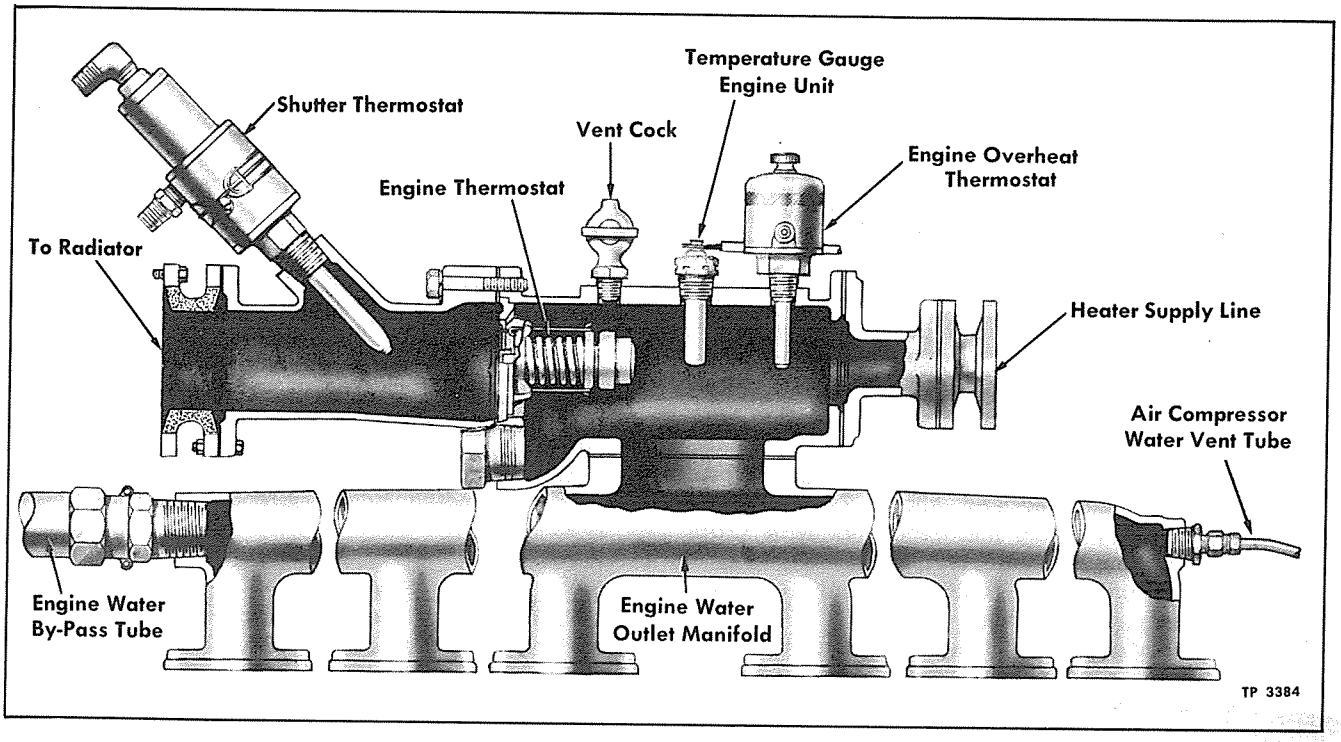


Figure 2—Sectional View of Engine Water Outlet Connection

Thermostat Maintenance

If action of the water temperature gauge, on instrument panel, indicates engine thermostat is fot functioning properly, remove thermostat and see if the component parts appear to be in good condition. If so, test action of assembly in water as follows:

Use a reliable thermometer to indicate temperature of water, also agitate water thoroughly at all times. Suspend thermostat in the water. Do not allow it to rest on bottom of container but be sure it is completely covered. Gradually heat water to opening temperature of thermostat valve, refer to "Specifications" at end of this section, then hold temperature of water there for two or three minutes to give thermostat an opportunity to react; then gradually increase temperature of water until fully opened temperature is reached.

Do not attempt to repair thermostat other than clean it of sludge, rust, or scale. If thermostat does not function properly, install a new one which has been checked as directed above and known to be functioning correctly. Use a new gasket when installing thermostat.

WATER TEMPERATURE INDICATOR

Water temperature indicator system consists of two electrically connected units; a sending unit mounted in engine water outlet and a registering gauge mounted on instrument panel.

System is interconnected with control switch as shown on Wiring Diagram (Sec. 7A of this manual) so that system is inoperative when control switch is in "OFF" position.

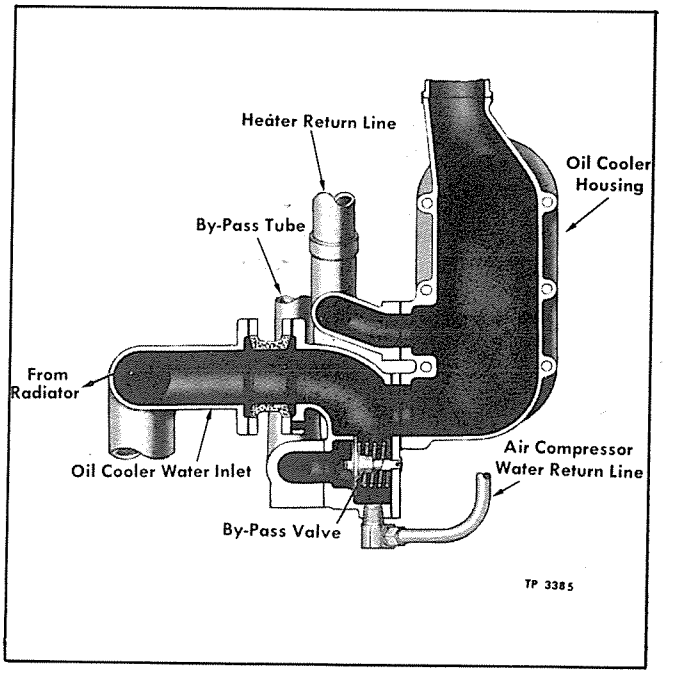


Figure 3—Sectional View of Oil Cooler Water Inlet

COOLING SYSTEM

Tests

If temperature gauge does not operate or show apparent false readings, with control switch turned on, check as follows:

1. Check No. 2 fuse to see if it is burned out.
2. If not, disconnect wire at engine unit terminal.
3. Connect one lead of a 1.5 candlepower 12-volt test lamp to battery terminal on starter solenoid. Touch other lead to body of engine sending unit. If bulb lights, unit is properly grounded. If bulb does not light, check for presence of sealing compound around threads of unit. Remove compound and repeat test.
4. Remove test lamp lead from body of unit, and touch lead to terminal on unit. If bulb lights engine unit is shorted and should be replaced.
5. Remove test lamp and reconnect wire from gauge unit to engine unit terminal.
6. Test wiring and units for current flow. Use test lamp as follows:

a. Connect one lead of test lamp to terminal on engine unit to which wire from control switch is connected. Connect other lead of test lamp to ground. If bulb fails to light, check wiring for open circuit.

b. Connect one lead of test lamp to gauge terminal to which engine unit si connected, and other lead to ground. If bulb fails to light, engine unit should be replaced.

c. Connect test lamp between other gauge terminal and ground. If bulb does not light, replace gauge.

7. If system still fails to function, trouble must be in the actuating elements of either the engine or gauge units or both and condition can be corrected by installing new unit in either or both of two positions.
8. Do not attempt to repair either engine or gauge units. When installing new engine unit do not use thread sealing compound on threads as this will increase electrical resistance of unit and cause faulty reading on gauge.

COOLING SYSTEM MAINTENANCE

Inspection of System

Systematic periodic inspection of units in cooling system is essential to maintain efficiency of system. Inspect at regular intervals as follows:

1. Check coolant in cooling system. Keep system filled to proper level. Check anti-freeze solution, if used.
2. Rust proof cooling system twice a year. Use a good chemically treated anti-freeze in the fall and a special rust preventive (inhibitor) with a fresh filling of water in the spring.
3. Check condition of all flexible couplings. Tighten or replace if necessary. Cracked, swollen, or deteriorated couplings should be replaced.
4. Check radiator core for leaks. Make certain that core is not clogged with dirt or insects. Clean out with compressed air, using low air pressure.
5. Inspect pump operation. A leaky water pump sucks in air which increases corrosion.
6. Repair all leaks. One drop of solution each ten seconds amounts to nearly one gallon lost in one week.
7. Inspect and tighten radiator mountings.
8. Test and replace thermostat if necessary. Bear in mind that causes of overheating in cooling system are not always traceable to defective operation of cooling units. Overheating causes originating from sources outside of the cooling system, are noted in Trouble Shooting (Sec. 21 of this manual).

Loss of Cooling Solutions

Solutions may be lost from cooling system through leaks, or overheating, which may be caused by.

1. "Hot spots" in rust and lime-clogged engine water jackets, causing steam which forces solution out surge tank overflow.
2. Air suction into system at leaky water pump or from low level in system.
3. Rust-clogged radiator.
4. Thermostat stuck in closed position.
5. Inoperative radiator shutters.

Draining and Filling Cooling System

Refer to Operation (Sec. O of this manual) for instructions on draining and filling cooling system.

Cleaning Cooling System

Unless water in cooling system is treated with a corrosion preventive, rust and scale will eventually clog water passages in radiator and jackets. This condition is aggravated in some localities by the formation of insoluble salts from water used.

Cleaning solutions are available which will successfully clean cooling systems of rust, scale, sludge, and grease, when used as directed by the manufacturer. However, if radiator is clogged with insuluble scale formations, reliable radiator service stations in the various localities are best equipped to remove such formations. Never use an alkaline type cleaner. Particularly at winter check-up, preferably before and after using anti-freeze solutions, radiator and entire cooling system should be cleaned with a reliable cleaning solution.

NOTE: Always follow instructions given by manufacturer of cleaning solution and equipment used.

Before pressure flushing cooling system, it is a good policy to tighten cylinder head bolts to prevent possible water leaks into cylinders and lubrication oil. Remove thermostat. Apply air gradually, as a clogged radiator will stand only limited pressure.

After cleaning operation is completed, be sure to check and test thermostat as described under "Thermostat." Clean out overflow pipe and blow insects and dirt from radiator air passages and grille.

GMC COOLING SYSTEM CLEANER

GMC Cleaner is especially developed to remove rust, scale, and corrision from the radiator and cylinder block water passages.

NOTE: Use cleaner only as instructed on label.

GMC COOLING SYSTEM SEALER

GMC sealer is very effective in stopping leaks in cylinder head, water jackets and radiator. Sealer may be used with any standard anti-freeze and will not clog water passages.

NOTE: Use sealer only as instructed on label.

CORROSION DAMAGES AND ITS PREVENTION

Water without an inhibitor not only causes corrosion in cooling system which interferes with circulation and cooling, but also corrosion damage to aluminum parts such as, upper and lower radiator tanks, radiator inlet and outlet fittings, engine water outlet manifold and possibly others to be added later. Some natural waters are highly corrosive to aluminum HENCE PREVENTIVE MEANS ARE EXTREMELY NECESSARY, particularly in the presence of ferrous metals (iron and steel).

Use of "soft," "deionized," or "distilled" water will aid greatly in reducing corrosion attack on aluminum parts and is recommended for use whenever possible.

Treatment of cooling system for the prevention of scale and rust formation has become an accepted automotive maintenance practice. This process consists of introducing into cooling system certain substances called "Inhibitors" which reduce or prevent corrosion of metals and deposition of scale, thus tending to maintain high cooling efficiency.

In general, inhibitors are not cleaners and will not remove scale and rust already formed. INHIBITORS SHOULD BE USED CONTINUOUSLY, preferably immediately after system has been thoroughly cleaned or when vehicle is new.

However, use of additional corrosion preventives or inhibitors is not recommended with "GM" or other anti-freeze preparations already containing an inhibitor, as an excessive amount may be harmful to rubber parts.

Following are the salient points concerning recommended inhibitors:

1. GMC Cooling System Corrosion Inhibitor

GMC inhibitor is a specially developed chemical water treatment designed to prevent excessive formation of corrosion and scale. GMC corrosion inhibitor should be used at all times with plain water, and with an uninhibited anti-freeze solution.

NOTE: Use inhibitor only as instructed on label.

2. Soluble Oil

Use only in plain water and in anti-freeze solutions which do not already contain an inhibitor, and in accordance with instructions issued by the soluble oil manufacturers; supply stations have available various soluble oil inhibitors. They are marketed under different names but their characteristics are similar.

When using soluble oil in plain water, or in uninhibited alcohol or methanol solutions, do not add too much. Soluble oil is not lost be evaporation and EXCESSIVE AMOUNTS ARE UNDESIRABLE; The amount of soluble oil in a cooling system syould never exceed 1% of the volume of the system. (See Anti-freeze Chart for capacity.)

3. Potassium Bichromate

Use only in plain water in proportion of two ounces of crystals to each five gallons of water. Potassium bichromate (dichromate) may be purchased from any drug or chemical house, or under a trade name at supply stations.

COLD WEATHER OPERATION

Plain water plus an inhibitor can be safely used as a cooling medium in climates where temperatures do not reach below 32°F. In cold regions, anti-freeze must be used.

Before installing anti-freeze solution, cooling system should be inspected and serviced for winter, as previously described under "Inspection" and "Cleaning Cooling System."

Cylinder head gaskets should be tightened or replaced, if necessary, to avoid possibility of anti-freeze solution leaking into engine and exhaust gases blowing into cooling system.

After anti-freeze solution has been installed, entire system should be inspected regularly to insure against development of leaks.

Thawing Cooling System

If cooling medium in system becomes frozen solid, place vehicle in warm building until ice is completely thawed out.

UNDER NO CIRCUMSTANCES SHOULD ENGINE BE RUN WHEN COOLING SYSTEM IS FROZEN SOLID.

COOLING SYSTEM

Anti-freeze Solution

Following information will assist in selecting anti-freeze solution best suited to meet individual driving conditions.

The most common commercial materials are:

Methanol (Methyl or Wood Alcohol)

Ethylene Glycol

Kerosene, Oils, or solutions containing calcium chloride, magnesium chloride, sodium silicate or other inorganic salts, honey, glucose, or sugar are not satisfactory for use in cooling system.

Methanol

Methanol is used extensively for anti-freeze solutions. Methanol anti-freeze solutions have the advantage of low first cost. There are, however, some disadvantages.

1. Methanol may be lost by evaporation, especially on warm days and on hard driving, and unless solution in radiator is tested periodically and sufficient anti-freeze added to replace loss, engine or radiator, or both, are liable to be damaged by subsequent freezing.

2. Vehicle finish may be damaged by contact with methanol solutions or vapors. Methanol accidentally spilled on finish should be flushed off immediately with large quantity of cold water without wiping or rubbing.

Ethylene Glycol

Ethylene glycol's first cost is usually higher than that of other types of anti-freeze. Ethylene glycol solutions, however, have the advantage of a higher boiling point and may be used at higher temperature, without loss, resulting in more efficient performance of cooling system. Ethylene glycol has the further advantage that in a tight system only water is required to replace evaporation losses. However, losses through leakage or foaming must be replaced by additional new solutions. Under ordinary conditions, ethylene glycol solutions are not injurious to body finish.

"GM Ethylene Glycol" is especially treated and compounded for use in cooling systems. Other ethylene glycol preparations are available, but only those containing suitable corrosion inhibitors and compounded for use in automotive cooling systems should be used, diluting them in accordance with instructions issued by the manufacturer.

Frequent inspection and test should be made for accidental leakage. If solution becomes brown or rusty colored, ocrrosion has taken place and solution should be immediately discarded and replaced with fresh solution,

Testing Anti-freeze Solution

Always test solution before adding water or anti-freeze. Engine should be warmed up to operating temperature. Fill and empty tester several times to warm tester before using. Keep tester clean inside and out.

Some testers will indicate correct freezing point only when test is made at a specific temperature.

Other testers are provided with thermometers and tables and indicate freezing points corresponding to readings made at various temperatures. Disregarding temperature of solution may cause an error as large as 30°F.

Some testing devices are made to test only one kind of anti-freezing solution. Others have several scales, and may be used for corresponding kinds of anti-freeze. Read, and be guided by, instructions furnished with tester.

MOTO-GARD AND TELL-TALE ALARM SYSTEM

Moto-Gard and tell-tale alarm system comprises a group of automatic electrical devices which prevent damage to engine due to loss of oil pressure or excessive coolant temperature by stopping the engine when either of these conditions occur. Operation of this system is explained in Operation (Sec. O of this manual). Maintenance and repair of units included in Wiring and Miscellaneous Electrical (Sec. 7A of this manual).

ANTI-FREEZE CHART
ALL QUANTITIES LISTED IN QUARTS

(76 Quarts Total Capacity)

Temperature	Methanol	Ethylene Glycol
+ 10 F.	19	19
0 F.	24	25
- 10 F.	28	29
- 20 F.	33	33
- 30 F.	38	36

COOLING SYSTEM CAPACITY

Engine, Radiator, Pipes and Fittings	62 qts.
Heating System	14 qts.

SPECIFICATIONS

THERMOSTAT - WATER CIRCULATION	
Starts to Open	168°F.
Fully Opened	195°F.
TEMPERATURE GAUGE	
Make	King Seeley
Type	
Gauge Unit	41245
Engine Unit	B-7000
Operating Range	100° - 212°F.
Voltage	6

Radiator and Shutter

Contents of This Section

Related Subjects in Other Sections

RADIATOR

Radiator is mounted on left side of vehicle in front of engine and is accessible through the radiator grille door. Surge tank, mounted in the upper left section of engine compartment, permits expansion of cooling liquid without loss from overflow. Excessive liquid or vapor in cooling system is exhausted through pressure valve and overflow tube which extends down side of radiator core.

The radiator is designed to cool the water under all operating conditions; however radiator core must be kept free from corrosion and scale at all times in addition to the maintenance of other cooling units in order to obtain satisfactory service.

Cleaning of radiator, inspection of connections and mountings, and use of corrosion preventives are essential periodic service procedures.

Radiator core should be periodically cleaned inside and out in a cleaning solution. At the same time, examine core for leaks and bent tubes, and repair if necessary. If radiator core requires painting, spray with special radiator paint. Do not use paint mixed with oil, as this type will form an insulation on core and prevent dissipation of heat.

RADIATOR REMOVAL

If necessary to remove radiator core for repair operations when power plant is in the chassis, proceed as follows:

1. Drain system. Drain cock is located at bottom radiator outlet connection.
2. Raise radiator grille door and secure with chain at rear quarter panel.
3. Disconnect air cylinder.
4. Remove shutters.
5. Disconnect radiator outlet hose.
6. Remove oil reservoir, then disconnect radiator inlet hose.

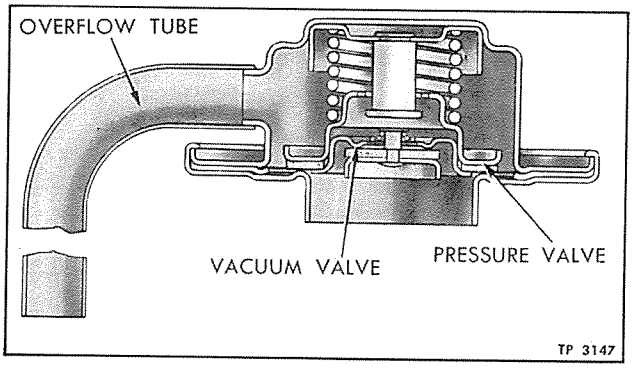


Figure 1—Sectional View of Surge Tank Pressure Valve

7. Remove radiator support bolt nuts, one on each side at top.
8. Disconnect radiator tie-rod at bottom of radiator.
9. Remove radiator and shroud assembly straight out through radiator grille openings.
10. Shroud can now be removed from radiator.

SURGE TANK PRESSURE VALVE (Fig. 1)

A valve incorporating a pressure valve and a vacuum valve is used to seal the cooling system. The valve is located on the surge tank and maintains a pressure of approximately 4 lbs. within the cooling system when the engine has warmed up to normal operating temperature. Steam or vapor can escape from the cooling system, when necessary, through the pressure valve while the purpose of the vacuum valve is to permit atmosphere to enter the cooling system when cooling liquid contracts. The increased pressure within the cooling system raises the boiling point of the cooling liquid permitting a slightly higher engine operating temperature which results in improved engine performance and economy without danger of over-heating.

RADIATOR AND SHUTTER

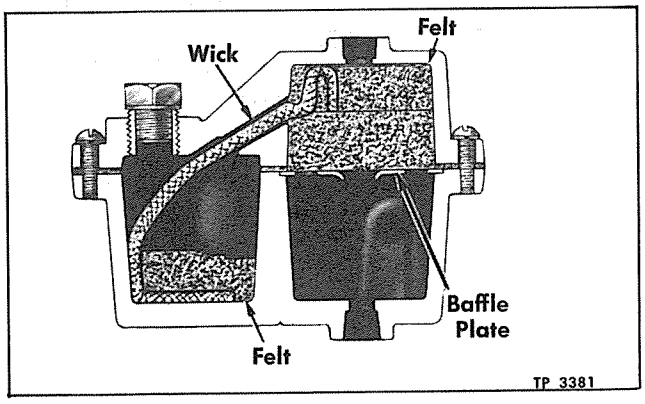


Figure 2—Sectional View of Radiator Shutter Air Filter

Pressure valve also reduces evaporation of cooling liquid and prevents its surging into upper tank after engine has been stopped following a hard drive in hot weather.

RADIATOR SHUTTER

Radiator shutter and controls combine thermostatic control with air power actuation. With this arrangement, radiator shutter operating linkage is connected to an air chamber. Operation of air chamber is controlled by a thermostat in water line between engine and radiator. Thermostat is set to open and close at temperatures noted in "Specifications" section.

RADIATOR SHUTTER ASSEMBLY

Maintain radiator unit in free working condition by cleaning vane bearings thoroughly with brush or spray gun, or both. Use gasoline or penetrating oil until all dirt is removed. After shutter is once worn in, lubricating oil may be omitted after cleaning. Frictional wear is very slight, and excessive lubricant may increase rapid collection of dirt. This attention is recommended every 2000 or 5000 miles. depending upon the nature of operation and the tending toward dirt collection.

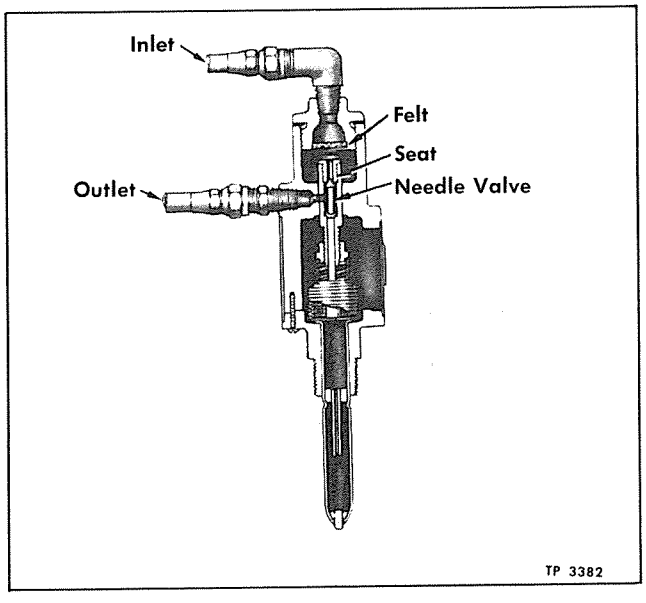


Figure 3—Sectional View of Radiator Shutter Thermostat

AIR FILTER

Air filter, shown in (figure 2), prevents moisture from entering shutter thermostat. As air from air tank enters filter, it strikes against baffle which diverts moisture in air stream to bottom of housing. Air then passes through felt filtering element. Air is again filtered through felt before entering thermostat air valves. Periodic check should be made for leakage at filter connections. Tighten if necessary. With felt inserted, air filter chamber holds slightly over one ounce of fluid.

Add fluid to filter through filler plug. Refer to Lubrication Chart for intervals, quantity and type of fluid to use. Larger quantities or more frequent filling may overload system.

Air filter should be drained at intervals shown in Lubricating Chart by opening pet cock at bottom. This operation should be performed under pressure.

Every 10,000 miles, air filter should be disassembled and the felt cleaned with cleaning solvent or replaced.

RADIATOR SHUTTER THERMOSTAT

Thermostat, shown in figure 3, functions automatically according to engine temperature, opening and closing air line to the air chamber which in turn operates the radiator shutter.

At periodic intervals thermostat must be cleaned by disconnecting inlet line and injecting a clean ing fluid into the thermostat. Refer to Lubrication Chart for intervals, quantity, and type of fluid to use. When air line is reconnected pressure will force fluid through thermostat needle valve cleaning away any deposits of foreign matter.

Thermostat should be disassembled and cleaned once or twice per year. Disassemble by removing end caps and needle valve upper seat. Wash needle valve thoroughly in a reliable solvent. Do not use any abrasive or metal tools in removing deposits from needle valve or seats. A pointed wooden stick provides a practical method of cleaning tapered seats. Care must be taken to have all parts thoroughly cleaned before reassembling. Felts must be renewed or thoroughly washed in solvent not neglecting small felts found in side openings.

Testing Thermostat

When thermostat is completely assembled except for base and cover, needle travel should be measured accurately and set to .005" - .006" by using a dial indicator.

After complete reassembly, test and reset thermostat to assure correct operation. This can be done by using portable tester such as listed under "Special Tools" at end of this section. This tester has an electric heating unit, a circulating water pump, and attachments to duplicate actual conditions which exist when the thermostat is installed in the engine. Thermostat is inserted in tester and line protruding from top of tester is connected to end of thermostat. Air line to pressure gauge is connected to side of thermostat. After connecting electric cord and air line to tester and filling tester with water at cup at right side, the instrument is ready for use. The switches at right control electric heating unit and circulating pump, and the pressure gauge will indicate points at which thermostatic valve acts. By moving the adjusting nut in or out, the setting can be made accurately so that, when placed in the engine, the shutter will open and close at the desired temperature. See "Specifications" at end of this section.

AIR CHAMBER

Air chamber, shown in figure 4, is controlled by the thermostat and automatically opens and closes radiator shutter according to engine temperature.

Air Chamber Serviceability Tests

1. Operation. With maximum pressure in air system and engine temperature below normal operating temperature, shutter should be closed. When engine temperature reaches normal operating temperature shutter should open.

2. Leakage. With maximum pressure in air system and shutter closed, coat, with soap suds, the bolting flanges holding the diaphragm in place between the pressure plate and the non-pressure plate. No leakage is permissible. If leakage is evident, tighten flange bolts. NOTE: All flange bolts must be tightened evenly and only sufficiently to prevent leakage, otherwise the diaphragm will become distorted and premature failure will result.

Also, with maximum pressure in air system and engine temperature below normal operating temperature, check for leakage through diaphragm by coating the clearance hole around the push rod and the drain holes in the non-pressure plate with soap suds. No leakage is permissible. If leakage is evident, the diaphragm must be replaced.

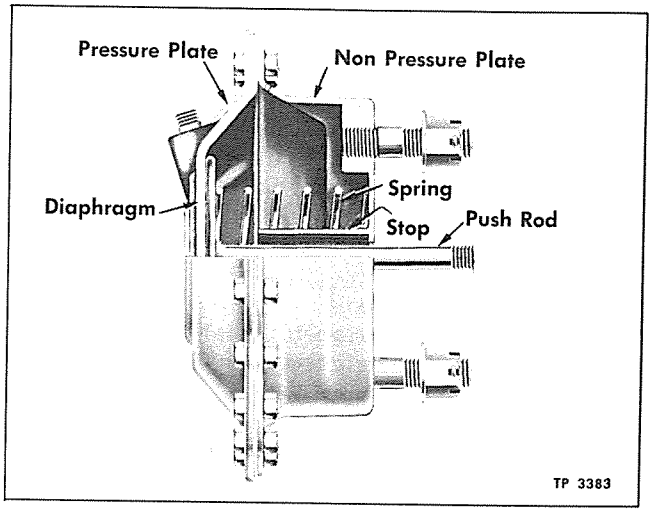


Figure 4—Sectional View of Radiator Shutter Air Chamber

Air Chamber Diaphragm Replacement
(Refer to Fig. 4)

Before disassembling air chamber, mark pressure plate and the non-pressure plate so that the air inlet opening in the pressure plate can be reassembled in the correct relationship to the non-pressure plate.

When installing diaphragm be sure to place diaphragm in pressure plate with edges of diaphragm inside of cupped flange of pressure plate, then assemble pressure and non-pressure plates in correct relationship as marked at time of disassembly.

As stated under "Serviceability Tests" tighten flange bolts only tight enough to insure an air tight seal but not enough to distort the diaphragm.

SPECIFICATIONS

SURGE TANK PRESSURE VALVE

Valve opens (Pressure in Pounds per sq. in.)	3-1/2 - 4-1/2

RADIATOR

Type	Finn and Tube
Frontal Area	858 Sq. in.
Thickness	4 in.

RADIATOR SHUTTER THERMOSTAT

Make	Kysor
Valve Closes at	180°F.

RADIATOR AND SHUTTER

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however, are not supplied by GMC Truck & Coach Division. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

Name of Tool	Vendor
Shutter Thermostat Dial Indicator	Kysor Heating Company..... Detroit, Mich.
Shutter Thermostat Testing Unit	

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference--Make note of bulletin number in space below:

NOTES

Fan and Water Pump

Contents of This Section

Related Subjects in Other Sections

Subject	Page
Cooling System - General	129
Radiator and Shutter	135
Engine	193
Lubrication	209

FAN AND DRIVE

Fan assembly is mounted to engine crankshaft front cover by means of bracket, as shown in figure 1, and is driven from crankshaft pulley by pair of matched belts.

Fan blade spacer is bolted to fan drive pulley which revolves on double row ball bearing, inner race of which is secured to fan drive spindle by a nut and lock. Outer race of bearing is held in pulley by fan spacer as shown in figure 1. A lip type oil seal, pressed into pulley, wipes

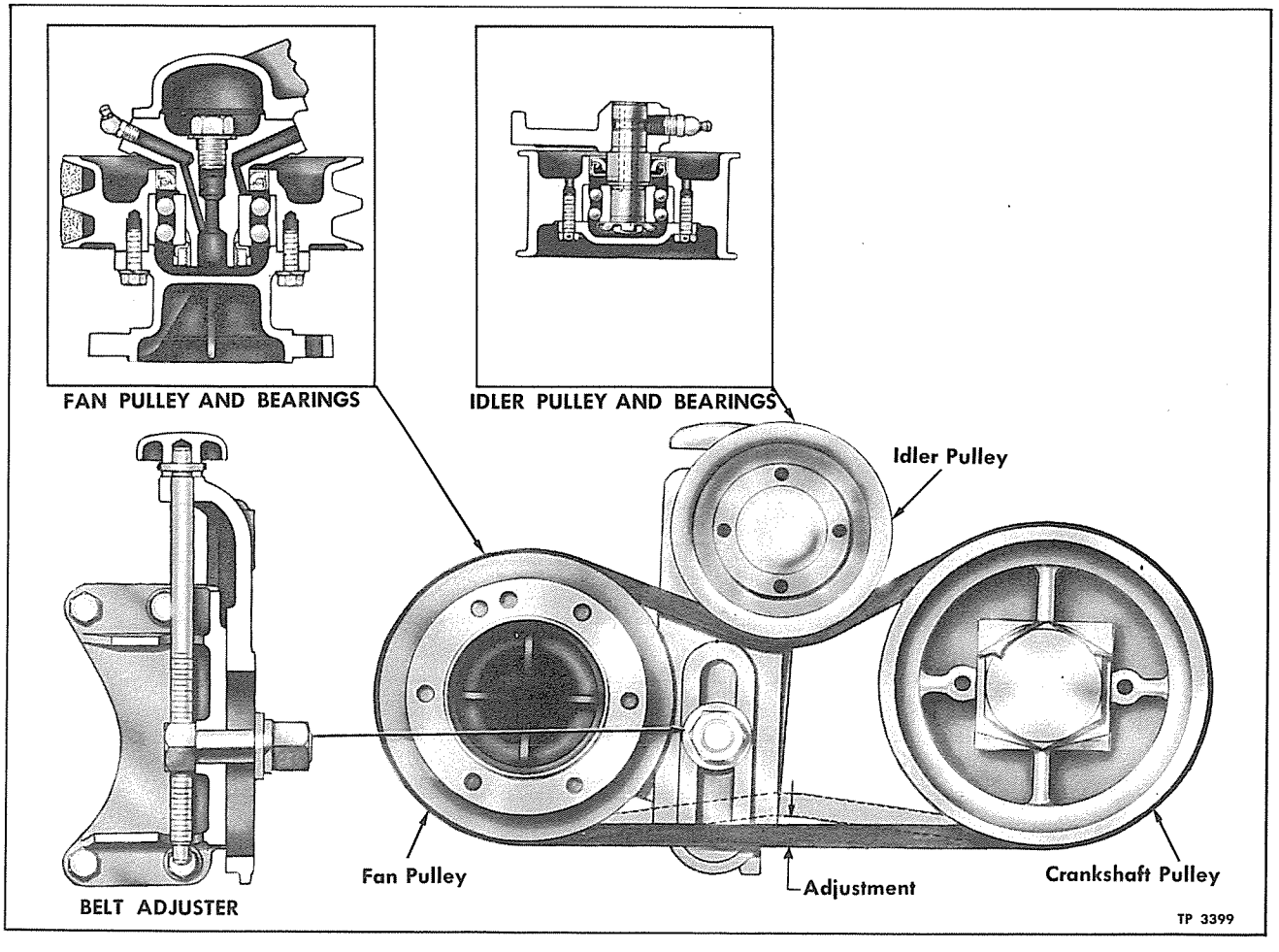


Figure 1—Fan and Drive

FAN AND WATER PUMP

on spindle to retain lubricant in bearing. A relief hole is provided in spindle to relieve excess lubricant. Lubricate as described in Lubrication (Sec. 13 of this manual).

FAN IDLER PULLEY

Fan idler pulley, mounted as shown in figure 1, revolves on a double row ball bearing, inner race of which is secured to shaft by nut and lock. Shaft is a press fit in idler pulley bracket. Bearing outer race is held in pulley by a retainer bolted to pulley. A lip type oil seal, pressed into pulley, wipes on shaft to retain lubricant in bearing. A relief hole is drilled in shaft to relieve excess lubricant. Lubricate as directed in Lubrication (Sec. 13 of this manual).

FAN BELT ADJUSTMENT

To adjust fan belt, loosen idler pulley bracket clamp bolt nut; then turn idler pulley adjusting screw handle as necessary to adjust belt so that a light pressure on belt, midway between pulleys, will cause 1/2 to 3/4 inch deflection as shown in figure 1. Be sure to tighten clamp bolt nut after belt adjustment is completed.

WATER PUMP

Description and instructions for maintenance of water pump used in Diesel engine equipped vehicles are contained in separate maintenance manual for Diesel engine (Form X-4517).

SPECIFICATIONS

FAN

Drive ..... Crankshaft

Number of Blades 6

Diameter ..... 26"

Rotation .....Counterclockwise

WATER PUMP
(See Diesel Engine Maintenance Manual).

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference - Make note of bulletin number in space below:

NOTES

Wiring and Miscellaneous Electrical

Contents of This Section

Related Subjects in Other Sections

Wiring diagram (fig. 1) illustrated in this section shows all standard electrical units and circuits. Position of electrical units is shown diagramatically.

Wiring diagrams covering heating and ventilation will be found in Body (Sec. 3B of this manual). Additional wiring diagrams covering special equipment units will be found in other sections of this manual in which equipment is covered.

A complete list of all electrical and mechanical control units, etc., and function of each are given in Operation (Sec. O, of this manual).

INDEX OF ELECTRICAL UNITS

Certain electrical equipment is covered in other sections of this manual. Both electrical and other sections describe and illustrate various electrical units. Service information and test specifications are given in each section as follows:

WIRING AND MISC. ELEC.

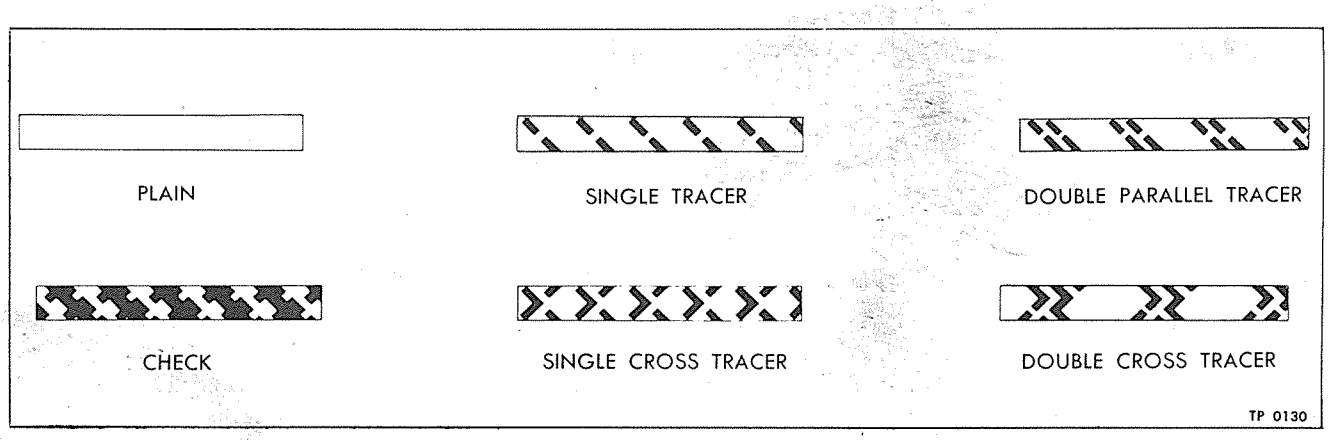
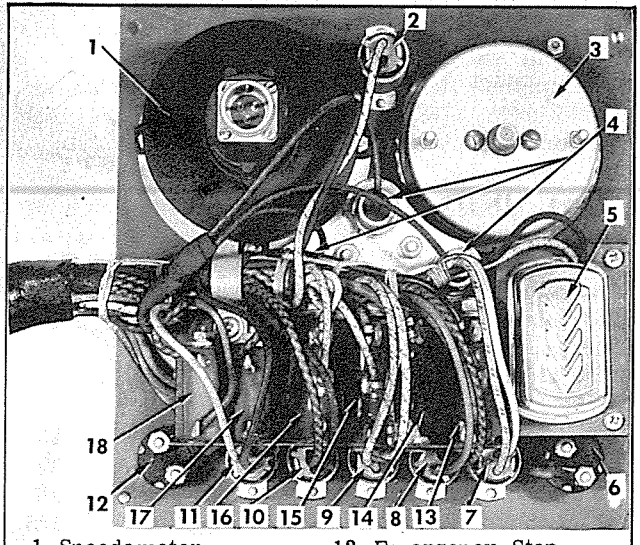


Figure 2—Wire Tracing Chart

TESTING CIRCUITS

Methods of testing various circuits are described in respective sections. However, circuits may be tested for continuous circuit or shorts with test light or low-reading voltmeter.

All electrical connections must be clean and tight. Loose and corroded connections will cause run-down battery, difficult starting, dim lights, and improper function of electrical units. Inspect all wiring and connections at regular intervals. Refer to other sections listed above for maintenance instructions on various units and circuits.



1 Speedometer
2 Headlight Hi-Beam Tell-Tale
3 Air Pressure Gauge
4 Instrument Lights
5 Alarm Buzzer
6 Starter Button
7 Hot Engine Tell-Tale
8 Low Air Tell-Tale
9 Low Oil Tell-Tale
10 Emergency Door Tell-Tale
11 Stop Light Tell-Tale
12 Emergency Stop Button
13 Oil and Temperature Gauge Resistor
14 Low Oil and Water Overheat Alarm Resistor
15 Low Oil Tell-Tale Resistor
16 Water Overheat Tell-Tale Resistor
17 Emergency Door Tell-Tale Resistor
18 Low Air Tell-Tale Resistor

TP 3602

Figure 3—Rear View of Driver's Gauge Panel

WIRE SIZES AND TRACER COLORS

Each wire in electrical system is of a specific size as designated on wiring diagrams. When replacing wires, correct size as indicated must be used.

The insulation of each wire is distinctly patterned and colored to assist in tracing and testing circuits also in making correct connections.

Tracing colors are designated on each wire on diagram and the pattern chart (fig. 2) will serve to identify patterns.

DRIVER'S GAUGE PANEL

A driver's gauge panel is mounted in an easily visible position at front of driver. Refer to Operation (Sec. O of this manual) for operating instructions. The panel contains the following gauges, switches and lights.

Gauges & Switches	Tell-Tale Lights
Air Pressure Gauge	Headlight High Beam
Oil Pressure Gauge	Hot Engine
Water Temp. Gauge	Low Air
Gen. Charge Indicator	Low Oil
Starter Button	Emergency Door
Emergency Stop Button	Stop Lamp
Speedometer	

In addition to the above units on the face of the panel, there are six resistor units and an alarm buzzer mounted on the rear of the panel (fig. 3).

FUSE PANEL

A fuse panel is mounted on dash at front of vehicle. Fuses on this panel are easily accesible by opening a door, which is unlocked with the door wrench. Each fuse is numbered for easy identification. Spare fuses of various ampere capacity are mounted on rear of fuse panel door. When necessary to replace a blown fuse select a spare of the same size which insures the proper amperage. Refer to wiring diagram (fig. 1) for identification of various circuits and fuse numbers. Fuse panel, with door open, is illustrated in figure 4 while fuse panel junctions are shown in figure 5.

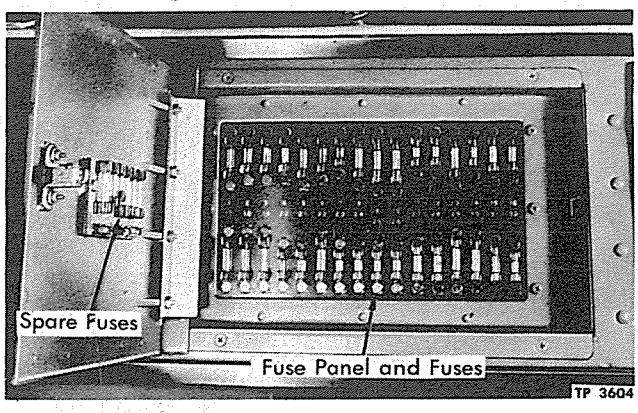


Figure 4—Fuse Panel

The following tabulation lists fuse number, amperage, circuit and wire size and color:

Fuse No.	Amperes	Circuit	Wire Size and Color
1	20	Reverse and Starter Switches	No. 14 Blue
	—	Feed to #1 to #4 Buss Bar	No. 12 Green
2	14	Oil Pressure and Water Temperature Gauges	No. 14 Red-Black Tr.
3	14	Tell-Tale Alarm Relay Feed	No. 16 White
4	14	Passenger Buzzer	No. 16 Brown-Bl. Red Cr. Tr.
5	20	Head Light Dimmer Switch Feed	No. 12 Brown-Bl. Red Cr. Tr.
6	14	Fog Light Foot Switch Feed	No. 12 Green
7	9	Front Corner Marker Lights	No. 16 Green
8	—	#8 to #10 Buss Bar Feed	No. 4 Brown-Bl. Red Cr. Tr.
	20	Instrument Panel, Rear Marker, Tail and Target Sign Lights	No. 16 Black-Green Tr.
9	30	Reading Lights (2,4,5,7 R.H. and 2,5,7,9 L.H.)	No. 10 Red
10	30	Reading Lights (1,3,6,8 R.H. and 1,3,4,6,8 L.H.)	No. 10 Green
11	9	Michigan Markers - Front	No. 16 Black-Red Ch.
12	9	Michigan Markers - Rear	No. 16 Red-Bl. Tr.
13	20	Clearance Lights	No. 14 Black-Red Ch.
14	9	Front Emblem	No. 16 Black-Tan Tr.
		Destination Sign and Night Lights	No. 14 Black Tan Tr.
15	14	General Lighting (2,4,5,7 R.H. and 2,5,7,9 L.H.)	No. 12 Brown
16	14	General Lighting (1,3,6,8 R.H. and 1,3,4,6,8 L.H.)	No. 12 Blue
17	20	Indirect Lights (1,3,5,7,9,11,13 R. and L.)	No. 12 White
18	20	Indirect Lights (2,4,6,8,10,12 R. and L.)	No. 12 Brown-Bl. Red. Cr. Tr.
19	20	Defrosters - R. and L.	No. 14 Black-Gr. Ch.
20	9	Baggage Compartment Lights	No. 14 Green-Bl. Tr.
21	9	Step Lights	No. 16 Yellow - 2 Blue Tr.
22	20	Engine Stop	No. 14 Green
23	—	Feed From Dimmer Switch to #23 and #24 Buss Bar	No. 12 Yellow-Bl. Tr.
	9	L.H. Headlight Hi-Beam	No. 14 White-Bl. Cr. Tr.
		Headlight Hi-Beam Tell-Tale	No. 16 White-Black Tr.
24	9	R.H. Headlight Hi-Beam	No. 14 White-Bl. Tr.
25	—	Feed From Dimmer Switch to #25 and #26 Buss Bar	No. 12 Yellow
	9	L.H. Headlight Low Beam	No. 16 White-Green Cr. Tr.
26	9	L.H. Headlight Low Beam	No. 16 White-Green Cr. Tr.
27	14	Fresh Air Blower - R.H.	No. 14 Yellow
28	—	Feed to #27 and #28 Buss Bar	No. 12 White-Red Tr.
	14	Fresh Air Blower L.H.	No. 14 Red
29	—	Feed to #29 to #32 Buss Bar	No. 8 Red
	20	Horn Relay Feed	No. 10 Yellow
		Spot Light	No. 16 White
30	20	Driver's Light	No. 16 Blue-Yellow Tr.
31	14	Stop Light	No. 14 Green-Black Tr.
32	—	Emergency Stop Feed	No. 14 Brown-Red Tr.
		Directional Signals	No. 16 White-Green Cr. Tr,

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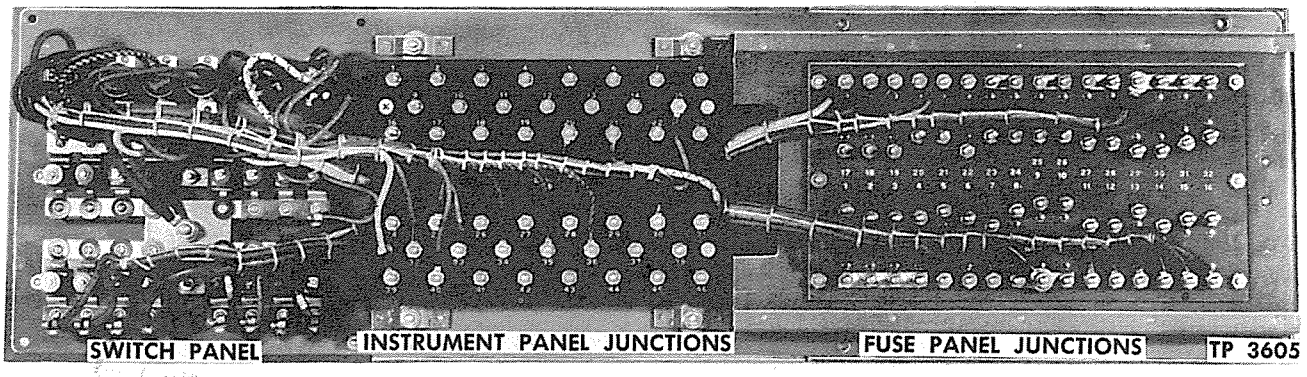

Figure 5—Rear View of Switch Panel, Fuse Panel, and Instrument Panel Junctions.

INSTRUMENT PANEL JUNCTIONS

Instrument panel junctions are located at front of vehicle behind a panel assembly. Refer to figure 5 for illustration of junctions.

The following tabulation lists terminal number, circuit and wire size and color. Refer also to wiring diagram (fig. 1) for circuit identification.

(See Triangular △ Symbol On Wiring Diagram)

Term No.	Circuit	Wire Size and Color
1	Moto-Gard	No. 14 Red-Black Tr.
2	Reverse Switch	No. 14 Blue
3	Starter Switch	No. 14 Red
4	Tell-Tale Alarm	No. 14 Brown-Black-Red Cr. Tr.
5	Charge Indicator	No. 14 Brown-Black Tr.
6	Water Overheat Thermostat	No. 16 Yellow
7	Water Temperature	No. 16 Blue-Yellow Tr.
8	Engine Emergency Stop	No. 14 Brown-Red Tr.
9	Low Oil Pressure	No. 16 White-Black & Gr. Cr. Tr.
10	Oil Pressure	No. 16 White - 2 Green Tr.
11	Directional Lights Tell-Tale	No. 16 White
12	Directional Light	No. 16 Green
13	Horn	No. 16 Black-White Tr.
14	Stop Lights	No. 16 Red
15	Stop Lights Switch	No. 14 Green-Black Tr.
16	Horn	No. 10 Brown-Bl. & Red Cr. Tr.
17	Low Air Pressure Switch	No. 16 Blue
18	Directional Lights - L.H.	No. 16 White-Black Cr. Tr.
19	Directional Lights - R.H.	No. 16 White-Red Cr. Tr.
20	Air Conditioning "Turn On" Tell-Tale	No. 16 Black-Yellow Cr.
21	Air Conditioning "Turn Off" Tell-Tale	No. 16 Brown-Black Tr.
22	Passenger Buzzer	No. 16 Brown-Black & Red Cr. Tr.
23	Emergency Door Switch	No. 16 Black-Red Tr.
24	Fresh Air Blower Magnetic Switch	No. 12 Red-White Tr.
25	Fresh Air Blower Cut-out Switch (Except N.Y. State)	No. 16 Green-Red Tr.
26	Moto-Gard and Tell-Tale Alarm Relay	No. 16 White - 2 Black Tr.
27	Tell-Tale Alarm Buzzer	No. 16 Yellow-Red Tr.
28	Stop Light Tell-Tale	No. 16 White-Red Tr.
29	Low Air Pressure Tell-Tale	No. 16 Black-Red Ch.
30	Ground	
31	Driver's Blower Switch	No. 12 White-Black Cr. Tr.
32	Air Conditioning Ignition	No. 14 Green-Black Tr.
33	Main Blower Magnetic Switch	No. 14 Green-White Tr.
34	Air Conditioning Engine Starter	No. 14 Black-Green Tr.
35	Air Conditioning Engine Starting Ignition	No. 14 Black-Tan Tr.
36	Air Conditioning "Stop Engine" Tell-Tale	No. 16 Black-Green Ch.
37	Stop Lights Relay	No. 14 Black-Red Tr.
38	Stop Lights in Target Sign	No. 16 Red-White Tr.
39	Charge Indicator	No. 14 White
40	Charge Indicator	No. 14 Green-Red Tr.

BODY JUNCTIONS

Body junction panel is located over the driver's window. Junction terminals are accessible by removing small panel at inside of body. Each terminal is numbered for easy identification.

The following tabulation and wiring diagram (fig. 1) will serve to identify each terminal, circuit and wire size and color.

(See Hexagon ⬡ Symbol On Wiring Diagram)

Term No.	Circuit	Wire Size and Color
1	Destination Sign and Light Lights	No. 14 & 16 Black-Tan Tr.
2	Front Corner Marker Lights	No. 16 Green
3	Reading Lights (#1,3,6,8 R.H. & 1,3,4,6,8 L.H.)	No. 10 & 12 Green
4	General Lighting (#1,3,6,8 R.H. & 1,3,4,6,8 L.H.)	No. 14 Blue
5	Reading Lights (#2,4,5,7 R.H. & 2,5,7,9 L.H.)	No. 12 Red
6	General Lighting (#2,4,5,7 R.H. & 2,5,7,9 L.H.)	No. 14 Brown
7	Passenger Buzzer Switches	No. 16 Brown Bl. & Red Cr. Tr.
8	Michigan Markers - Rear	No. 16 Red-Black Tr.
9	Fresh Air Blower - R.H.	No. 14 Yellow
10	Rear Corner Marker Lights	No. 16 Black-Green Tr.
11	Fresh Air Blower - L.H.	No. 14 Red
12	Indirect Lights (#1,3,5,7,9,11,13 R. & L.)	No. 14 White
13	Emergency Door Switch	No. 16 Black-Red Tr.
14	Indirect Lights (#2,4,6,8,10,12 R. & L.)	No. 14 Brown-Bl. & Red Cr. Tr.

ENGINE COMPARTMENT PANEL

Engine compartment panel (fig. 6) is located at right rear corner of vehicle. Assembly consists of master fuse, starter circuit and engine compartment light fuses, starter solenoid and starter cut-out relays, spare master fuse and six post junction block. Assembly is accessible through a door at right rear corner of vehicle.

The following tabulation and wiring diagram (fig. 1) will serve to identify each terminal, circuit and wire size and color.

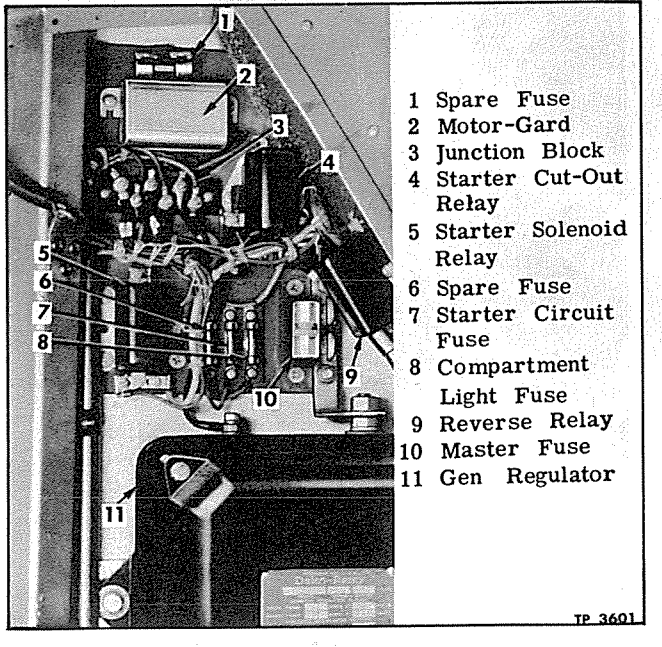

Figure 6—Engine Compartment Panel

(See Square □ Symbol On Wiring Diagram)

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ENGINE DISCONNECT PLUG

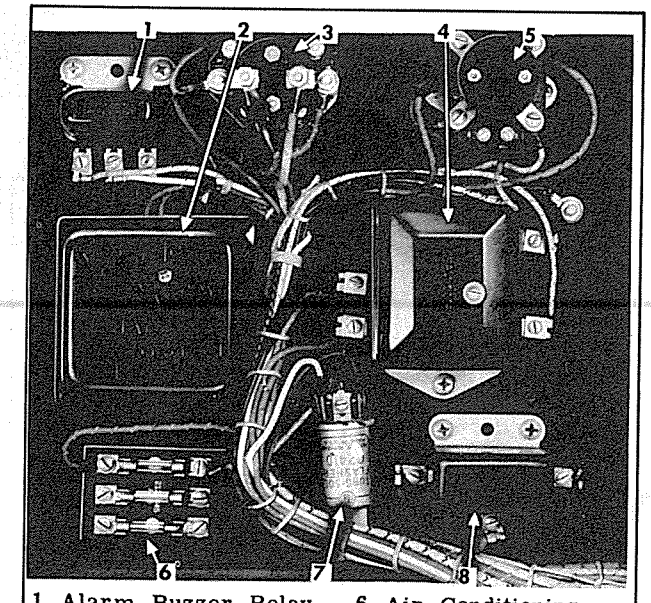
An engine disconnect plug is mounted on engine compartment panel at right side of vehicle. This plug provides a quick and easy means of disconnecting engine electrical units whenever engine is to be replaced.

The following tabulation and wiring diagram (fig. 1) will serve to identify each circuit and wire size and color.

(See Symbol X On Wiring Diagram)

BEFORE Chassis No. 101	AFTER Chassis No. 100	Circuit	Wire Size and Color
C	A	Oil Pressure Gauge	No. 16 White - 2 Green Tr.
H	B	Water Temperature Gauge	No. 16 Blue-Yellow Tr.
E	C	Water Overheat Thermostat	No. 16 Yellow
G	D	Generator Ground	No. 14 Black
I	E	Starter Solenoid	No. 10 Red
A	F	Generator Field	No. 14 Black-Red Ch.
F	G	Emergency Stop Solenoid	No. 14 Brown-Red Tr.
B	H	Engine Stop Solenoid	No. 14 Green
D	I	Oil Pressure Switch	No. 16 White-Black & Gr. Cr. Tr.

ELECTRIC HORN



1 Alarm Buzzer Relay
2 Passenger Buzzer
3 Fresh Air Blower Relay
4 Stop Light Relay
5 Moto-Gard and Tell Tale Alarm Relay
6 Air Conditioning Fuse Panel
7 Directional Signal Flasher
8 Horn Relay

Figure 7—Buzzer and Relay Panel Assembly

Horn (fig. 8) operates on magnetic principle to produce warning signal. Current from battery flows through windings within horn when circuit is completed at horn button (switch). Horn circuit is protected by a fuse. Refer to wiring diagram (fig. 1) in this section.

Before adjusting horn check following conditions which affect performance:

LOW HORN VOLTAGE

If horn produces a weak signal, voltage at horn should be checked. Connect a voltmeter across horn terminals. The voltage reading should not be less than 11 volts. A lower reading indicates either a low battery or a high resistance. in horn circuit.

Loose or corroded connections in horn circuit should be corrected. Check for defective wiring by connecting separate test leads from horn to battery.

A loose connection or poor contact at horn push button may cause horn to operate intermittently. Shunt around horn button to determine whether there is poor contact at push button. Whenever wiring is replaced in horn circuit, use correct size, as shown on wiring diagram.

Horns usually have a rasping sound when vital parts are broken or loose. A loose back shell may affect tone. Tighten collar screws, mounting nuts, and studs. Replace all damaged parts.

The horn will not function properly if field windings within horn are open circuited, or grounded. Connect an ammeter in circuit at horn terminal. If there is no indication of current flowing wnen contact points are closed, windings are open circuited. The ammeter will indicate an excessive flow of current if windings are short circuited or grounded.

Windings may also be checked for grounded circuit with test lamp. Disconnect horn leads and touch one test point to one of horn terminals. If lamp lights, field windings are grounded.

Excessive arcing at contact points may be caused by improper current adjustment. An open circuit in condenser will cause excessive arcing at points and, in some cases, contacts will be held together.

HORN ADJUSTMENTS

If tone is not satisfactory after checking preceding conditions, adjust horn in following manner:

1. Remove shell from horn.
2. Connect ammeter in circuit at horn and adjust current consumption by varying position of adjusting nut. See "Specifications" at end of this section, for current consumption.
3. Loosen adjusting lock nut and turn adjusting nut to left or right to increase or decrease current.
4. Too much current will cause horn to have a spluttering sound. This adjustment is very sensitive. Move nut 1/10 turn at a time and lock in position each time before trying. If ammeter is not available, adjust according to sound.
5. Correct air gap between armature and core is important for proper tone. The gap must be uniform across entire surface of armature. Width of gap may be determined by using a feeler. Adjustments are made by use of air gap adjusting nuts. Refer to "Specifications" at end of this section for correct adjustment dimensions.

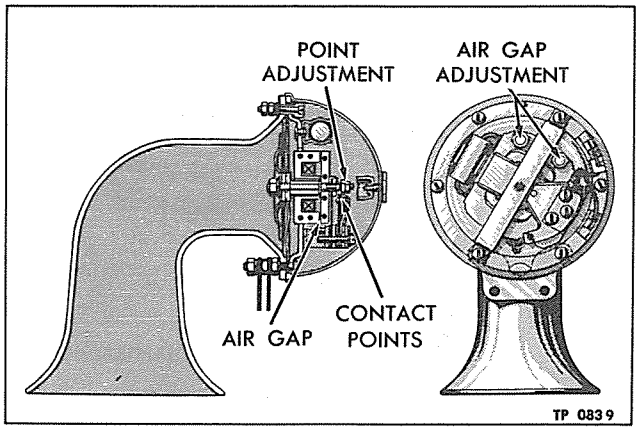


Figure 8—Electric Horn

HORN RELAY

Horn relay, illustrated sectionally in figure 9 is mounted on buzzer and relay panel assembly.

Relay is connected in such a manner that upon completion of circuit at horn button (switch) contact points are closed. Current is then fed directly from battery through contact points to horns, thus avoiding voltage drop through horn button circuit.

Maintenance and adjustment operations are given in following paragraphs. Removal of snap on cover will make relay mechanism available for adjustments.

Aid Gap Adjustment

With the contact points closed, measure the air gap between the armature and center of core. Adjust air gap by loosening two screws and move armature up or down as required (fig. 9). If necessary, align the support carrying the lower contact so that the air gap will be uniform between the core and the armature. Refer to "Specifications" at end of this section, for proper air gap.

Point Opening Adjustment

Measure the contact point opening with the armature in the open position. Adjust by bending armature stop (fig. 9). Refer to "Specifications" at end of this section, for correct point opening.

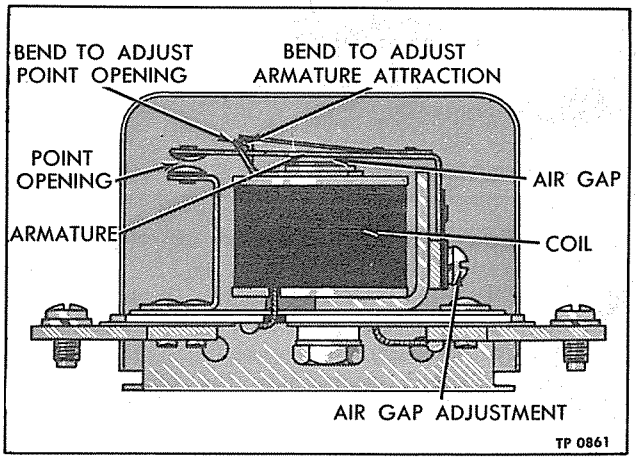


Figure 9—Horn Relay

Voltage Adjustment

Connect an accurate voltmeter across the "S" and "B" terminals, then connect a variable resistance from "S" terminal to ground. Adjust resistance, noting voltmeter reading at which points close. Reading should be same as listed in "Specifications" at end of this section.

Adjust, if necessary, by bending armature spring stop as required to obtain correct settings.

ALARM SYSTEM

An elaborate alarm system is used to warn the operator of four conditions requiring immediate attention. These four conditions are (1) Low Air Pressure (2) Emergency Door Not Closed (3) Low Oil Pressure (4) Water Overheated.

Whenever the air pressure is low or the emergency door is open an electrical circuit is completed through a tell-tale alarm relay which causes the buzzer to sound and one of the tell-tale lights to illuminate. If the buzzer sounds note

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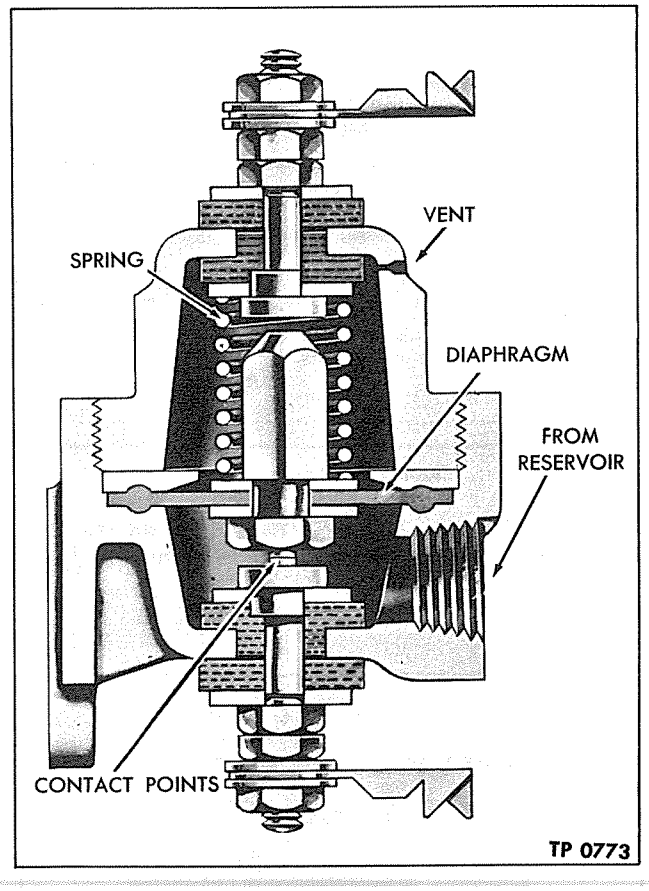

Figure 10—Low Air Pressure Indicator

which of the tell-tale lights is illuminated and take the necessary action to correct the condition.

If the oil pressure becomes dangerously low or water becomes overheated the buzzer sounds and tell-tale lights are illuminated. In addition, an electrical circuit is completed which causes emergency stop solenoid to operate and stop engine, except when transmission is in 1st speed.

Operation of the alarm system as it applies to the driver is explained under "Moto-Gard and Tell-Tale Alarm System" in Operation Sec. O, of this manual).

LOW AIR PRESSURE INDICATOR

The low air pressure indicator (fig. 10) is a safety device designed to automatically give a visual and audible warning when the air pressure in the air system falls below a safe limit for brake operation. The low pressure indicator is actually an air controlled switch in an electrical circuit, automatically controlling a tell-tale light on the gauge panel and a buzzer on the relay panel. Low pressure indicator is connected in air lines as shown in air lines diagram in "Brakes" (Sec. 4B of this manual).

OPERATION

The low pressure indicator shown in figure 10 is in cut-in position, that is, the pressure in the air brake system is below the specified limit (54 to 66 lbs.) and the contact points are closed, causing the tell-tale light to illuminate. When air pressure is built up in air brake system, which is connected to cavity under diaphragm, pressure under diaphragm overcomes spring tension above diaphragm, lifting the upper contact point off the lower contact point, breaking the electrical circuit to the tell-tale light.

The electrical circuit is connected through the engine control switch so that the tell-tale light will illuminate only when the control switch is in "Run" position. When the vehicle has been standing for a long period with the engine stopped and the air pressure is low, the tell-tale light will come on automatically when the control switch is turned on and will stay on until the pressure in the air brake system is built up to the specified limit. When operating vehicle on road and tell-tale light comes on, stop vehicle immediately and determine the cause of pressure loss.

SERVICEABILITY TESTS

1. Operating Tests

a. With no air pressure in system, turn control switch on and start engine. The low pressure tell-tale light must remain on until the pressure in the air brake system reaches a point between 54 and 66 pounds, at which point the tell-tale light must go out.

b. Continue to build up pressure in system to at least 75 pounds, then stop engine. Reduce the pressure in the air brake system by making brake application and note pressure when tell-tale light comes on. The light should come on when the pressure is lowered to a point between 66 and 54 pounds.

2. Leakage Test

With the air brake system fully charged, coat the outside of the low pressure indicator with soap suds to check for leakage. No leakage is permissible. Leakage at the lower terminal can sometimes be corrected by removing the electrical connection and carefully tightening the terminal nuts. Leakage through the small vent hole near the top of the unit signifies a leaking diaphragm. This condition requires replacing the diaphragm.

REPLACEMENT

1. Removal

Exhaust air pressure from system. Disconnect air line and electrical connections. Remove mounting bolts and remove unit from vehicle.

2. Installation

Position unit and install mounting bolts. Connect air lines and electrical connections. Build up air pressure in system and test unit as previously directed under "Serviceability Tests."

DISASSEMBLY

1. Unscrew top cover from body of unit. Remove spring, diaphragm washer, and diaphragm assembly.

2. Disassemble diaphragm assembly by removing nut from diaphragm screw and removing diaphragm and two washers from screw.

3. Remove terminals from cover or body by removing terminal nuts, flat washer, and fibre washer from terminals, then remove terminal with flat washer and fibre bushing from inside of cover or body.

INSPECTION AND REPAIR

1. Clean all metal parts thoroughly, using a suitable cleaning fluid.

2. Inspect diaphragm for signs of wear or cracking. Install new diaphragm if these conditions exists.

3. Inspect contact points for pitting or corrosion. If points are only slightly pitted or corroded, they can be repaired by carefully filing with a fine distributor point file. If points are badly pitted or corroded, the diaphragm screw and lower terminal, complete with new points, must be replaced with new parts.

ASSEMBLY

1. Select lower terminal (with contact point) and install flat washer with D-shaped hole in washer over D-shaped shoulder on head of terminal. Install fibre bushing on terminal, with D-shaped hole over shoulder on terminal and large side of bushing next to flat washer. Install the terminal, washer, and bushing in body with square shoulder of bushing in square hole in body. Install the following parts on the terminal in the order named: Rubber seal washer, fibre washer, flat washer, and two terminal nuts. Tighten nuts firmly.

2. Select upper terminal (without contact point) and install flat washer and fibre bushing on terminal head. Install terminal with washer and bushing in cover, with square shoulder on bushing in square hole in cover. Install fibre washer, flat washer, and two nuts on terminal and tighten nuts firmly.

3. To assemble diaphragm, place beveled washer on diaphragm screw with flat side of washer next to shoulder on screw. Install diaphragm on screw, then install another beveled washer with beveled side against diaphragm. Install nut on diaphragm screw and tighten only enough to form an air-tight seal, then stake nut in place. Excessively tightening nut will distort diaphragm.

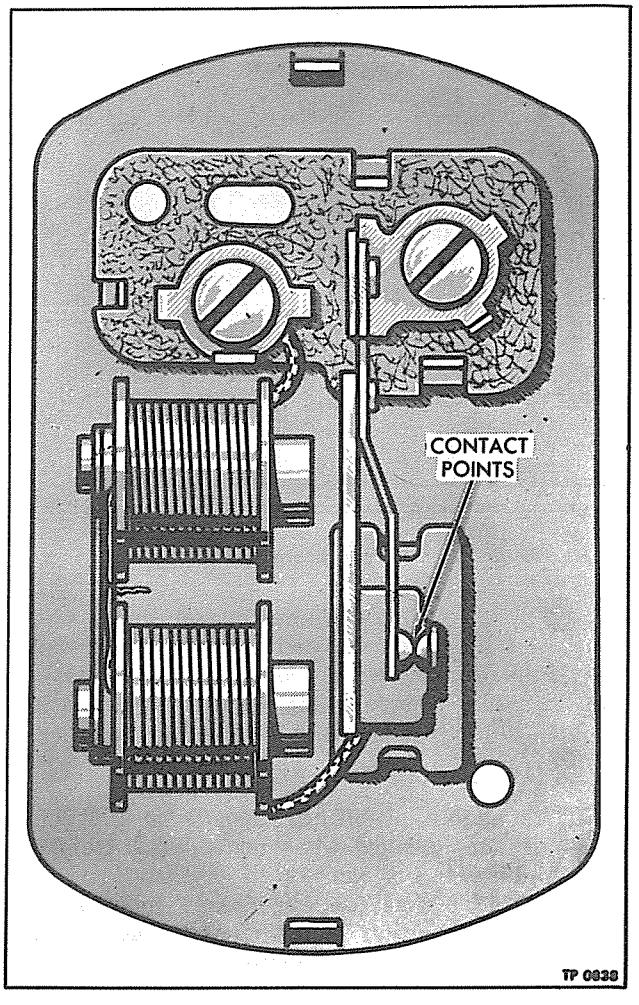

Figure 11—Tell-Tale Alarm Buzzer

4. Place diaphragm assembly in body and press down on edges of diaphragm with fingers to seat ridge on bottom of diaphragm in groove in body. Install diaphragm washer in body with beveled and grooved side next to diaphragm. Press washer firmly down to make sure the groove in washer is seated over ridge on top of diaphragm.

5. Place spring over diaphragm screw and install cover over spring. Compress spring and screw cover into body. After tightening cover, look through air inlet port to see that contact points are in proper alignment.

TELL-TALE ALARM BUZZER

Tell-tale alarm buzzer (fig. 11) is mounted on relay and buzzer panel (fig. 7) at rear of gang switch panel. Alarm buzzer warns the driver audibly of four conditions as follows (1) Low Air Pressure (2) Emergency Door Not Closed (3) Low Oil Pressure (4) Water Overheated. Buzzer is

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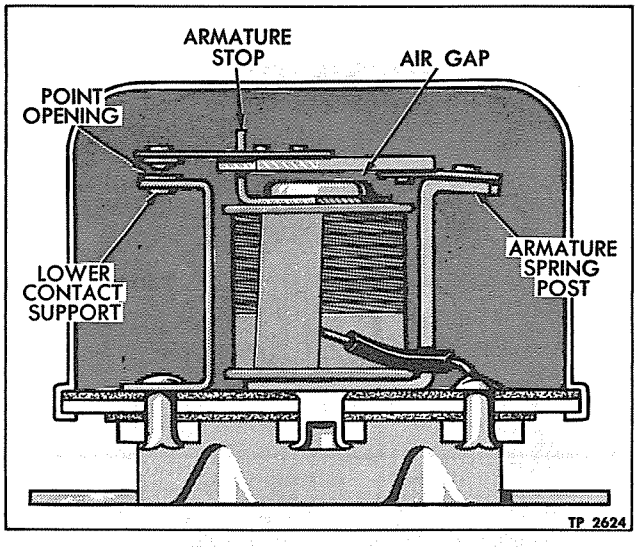

Figure 12—Tell-Tale Alarm Buzzer Relay

operated by the tell-tale alarm buzzer relay when condition 1 or 2 exists and through Moto-Gard tell-tale alarm relay when condition 3 or 4 exists. Refer to wiring diagram (fig. 1) for circuit, wire size and color and terminal junctions.

MAINTENANCE

Contact points of buzzer should be inspected periodically and cleaned when necessary. Remove cover of buzzer for access to points.

As a safety precaution, emergency door buzzer should be tested daily. Make sure engine control switch is turned on. Release emergency door latch; buzzer should sound. If buzzer does not sound, proceed as follows:

Test

1. If buzzer fails to operate, first make sure that No. 3 instrument panel fuse is not blown. Remove buzzer cover and make sure contact points are clean and in contact, and that terminal screws are tight. If buzzer still fails to operate, check circuit continuity in following sequence, using voltmeter or test light having a 12 volt, 1.5 candlepower bulb.

2. Turn engine control switch on. With one test lead grounded, touch other lead to both buzzer terminals. If no current is obtained at either terminal, defective wiring between instrument panel and buzzer is indicated.

3. Current should be obtained from one terminal of buzzer. With a jumper wire, ground the dead terminal - buzzer should sound.

4. If buzzer does not operate, remove buzzer for repair or replacement.

5. To test circuit (except buzzer), remove leads from buzzer and attach each lead to voltmeter or test light lead. If current indication is obtained when emergency door is unlatched, circuit (except buzzer) is operating properly.

6. If current indication is not obtained, switch and wiring should be carefully checked for open circuits.

TELL-TALE ALARM BUZZER RELAY

Tell-tale alarm buzzer relay (fig. 12) is used to complete low air pressure switch and emergency door switch electrical circuit to tell-tale alarm buzzer. Whenever either of these switches are closed an electrical circuit is completed through the relay which causes the buzzer to sound and warn the driver that one of these conditions exists. Relay is mounted on a buzzer relay panel (fig. 7) located behind gang switch panel. Refer to wiring diagram (fig. 1) for circuit, wire size and color and terminal junctions.

ADJUSTMENT

Refer to "Specifications" later in this section for air gap and point opening dimensions, and for closing voltage.

Air Gap

Disconnect lead from terminal "B." Check air gap between armature and core with contact points in closed position. Adjust by bending lower contact support (fig. 12). Align lower contact support so that air gap between core and armature will be uniform.

Contact Point Opening

Check contact point opening and adjust, if necessary, by bending armature stop (fig. 12). Clean contact points with a thin fine-cut contact file if pitted.

Closing Voltage

Connect lead of an accurate reading voltmeter to terminal "S" and other lead to terminal "B."

To check closing voltage with relay on vehicle, it will be necessary to insert a variable resistance of 10 ohms (capable of carrying 1 ampere) in series at "B" terminal on relay.

With horn button depressed, adjust variable resistance until relay points close and note reading on voltmeter. Adjust by bending armature spring post to increase or decrease tension on armature. Increasing tension increases closing voltage.

LOW OIL PRESSURE SWITCH

Low oil pressure switch is an electrical unit installed in the engine oiling system at a point where oil pressure exists. When engine is running the oil pressure acts upon a diaphragm to hold a pair of switch contacts open. However, if the

pressure should drop to between 2 and 4 lbs. pressure the points will close, thereby completing an electrical circuit.

Closing the points causes the tell-tale light to illuminate, Moto-Gard tell-tale alarm relay functions to cause alarm buzzer to sound, relay also permits current ot flow to a ground in the Moto-Gard. As current reaches the Moto-Gard a bi-metal element is heated causing contact points to close and current to flow to a special drum (rotary) switch. Switch is connected to transmission controls in such a manner that current reaches emergency stop solenoid, except when transmission is in 1st speed. Current reaching emergency stop solenoid immediately operates solenoid to close air choke valve and stop engine.

Refer to wiring diagram (fig. 1) for electrical circuits, terminals, wire sizes and colors.

Circuit Test

Circuit is connected to generator armature and therefore is not energized until generator is at charging speed.

With generator operating at charging speed, momentarily short the two wire terminals at engine pressure switch and note if tell-tale light is illuminated. If light is illuminated and buzzer sounds, the wiring, bulb, relay and buzzer are operating satisfactorily.

Failure of tell-tale to light or buzzer to sound inidcates that the circuit common to one or both of these units is at fault. Refer to wiring diagram (fig. 1) for circuit terminals.

WATER OVERHEAT THERMOSTAT

Water overheat thermostat is an electrical unit installed in the engine water manifold. When the water temperature becomes excessive an electrical circuit is completed. Completing the circuit causes a tell-tale light to illuminate, Moto-Gard tell-tale alarm relay functions to cause alarm buzzer to sound, relay also permits current to flow to a ground in Moto-Gard. As current reaches the Moto-Gard a bi-metal element is heated causing contact points to close and current to flow to a special drum (rotary) switch. Switch is connected to transmission controls in such a manner so that current reaches emergency stop solenoid except when transmission is in 1st speed. Current reaching the emergency stop solenoid immediately operates the solenoid to close the air choke valve and stop the engine. Refer to wiring diagram (fig. 1) for electrical circuit, terminals, wire size and colors.

Circuit Test

Circuit is connected to generator armature and therefore is not energized until generator is at charging speed.

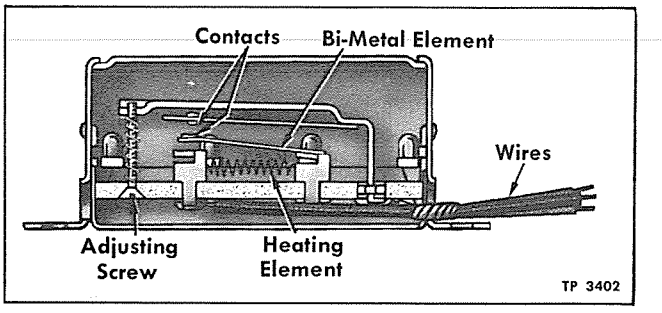

Figure 13—Moto-Gard

With generator operating at charging speed, momentarily short the wire at thermostat terminal and note if tell-tale light is illuminated. If light is illuminated and buzzer sounds, the wiring, bulb, relay and buzzer are operating satisfactorily.

Failure of tell-tale to light or buzzer to sound indicates that the circuit common to one or both of these units is at fault. Refer to wiring diagram (fig. 1) for circuit terminals.

MAINTENANCE

At 15,000 miles intervals remove thermostat cylindrical cover, clean contact points, if necessary, and blow out any dirt in the interior of the body.

At 30,000 mile intervals, the thermostat should be removed and tested for actual operation. This can easily be done by inserting tube of thermostat in oil heated to a temperature of 250 to 275 degrees F. If the points contact readily, correct working of the instrument is indicated. (The 250 to 275 degrees F. temperature for the testing oil is arbitrarily selected in order to make the check quickly and bears no relation to the temperature at which the thermostat is set.)

> NOTE: Before testing thermostat be sure that entire unit is pre-heated to approximately engine temperature (170 degrees F).

At any time excessive engine temperature causes the instrument to act, the thermostat should be removed from the vehicle and checked as above.

MOTO-GARD

Moto-Gard (fig. 13) is mounted on engine compartment panel (fig. 7) and is connected into wiring circuit as shown in wiring diagram (fig. 1).

The purpose of the Moto-Gard is to assist in completing an electrical circuit to emergency stop solenoid whenever oil pressure is low or

WIRING AND MISC. ELEC.

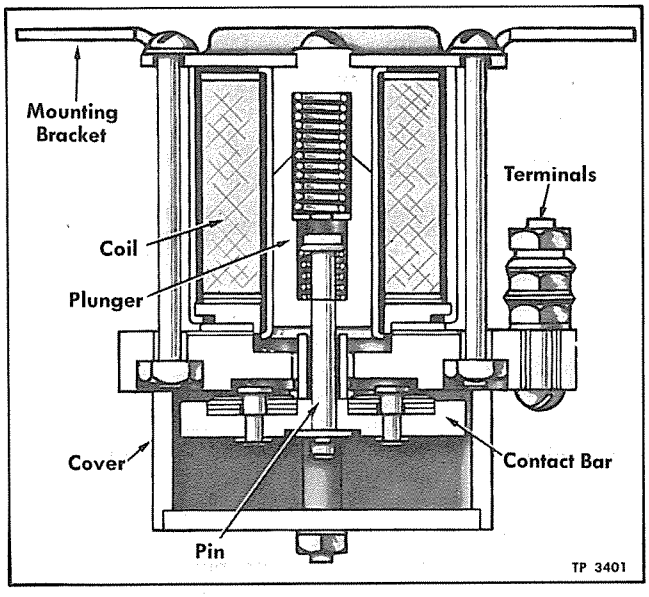

Figure 14—Moto-Gard and Tell-Tale Alarm Relay

water in engine is too hot. The action of the Moto-Gard is not immediate, as the bi-metal unit within the Moto-Gard must become heated before contact points close to complete the circuit. This requires approximately 20 seconds.

Test

Moto-Gard and wiring should be checked at approximately 5,000 mile intervals. To test, ground the wire from the low oil pressure switch or water overheat thermostat and at the same time accelerate the engine to a point where the generator is charging. The tell-tale light should illuminate immediately and the emergency stop solenoid should trip in less than 60 seconds. If the solenoid fails to operate check the wiring and test the solenoid. Do not ground the Moto-Gard for more than 1 minute at a time as it may be seriously damaged.

If the solenoid and wiring tests are satisfactory yet the Moto-Gard fails to stop the engine it should be replaced with a unit known to be operating satisfactorily.

DRUM SWITCH

A drum or rotary switch, installed in right side of engine compartment, is connected to transmission first speed lever. Purpose of switch is to permit vehicle operation in transmission first speed only, whenever the Moto-Gard circuit is energized by action of low oil pressure switch or water overheat thermostat.

Refer to Operation (Sec. O of this manual) also to wiring diagram (fig. 1) for electrical circuit.

Switch Maintenance

Switch contacts and terminals are enclosed within the switch body and should be cleaned at periodic intervals. Access to contacts is through a body cover held in place by a snap spring. Disconnect linkage and rotate switch. Use fine abrasive cloth to clean contact spring and drum. Clean terminals of accumulated corrosion or foreign matter. Reconnect linkage and install body cover.

SWITCH LINKAGE ADJUSTMENT

At time of installation the switch control linkage is properly adjusted and ordinarily should not require further attention, however an adjustment may sometimes be necessary. Remove clevis pin at switch lever. Place transmission in first speed. Remove cover from switch. Loosen yoke lock nut and turn yoke until clevis pin hole in yoke and switch lever are in alignment while switch is in neutral or no contact position. Install clevis pin and tighten yoke lock nut. Install switch cover and shift transmission into neutral.

MOTO-GARD AND TELL-TALE ALARM RELAY

Relay (fig. 14) is mounted on buzzer and relay panel (fig. 7). Purpose of this relay is to energize the alarm buzzer and Moto-Gard circuits whenever either the low oil pressure switch or water overheat thermostat contact points close to complete the circuit. Current for operation of the relay is supplied from generator armature and is therefore operative while generator is charging.

Refer to wiring diagram (fig. 1) for circuit and terminal identification.

INSPECTION AND CLEANING

Remove cover to inspect points. Points are silver and tend to oxidize (blacken), which does not impair efficiency. Clean points only if pitted or burned, and not if merely blackened. Caution: Do not use file or emery paper on points. Use only fine crocus cloth or preferably toilet tissue, and with very light pressure.

POINT REPLACEMENT

If points are badly burned, replace contact bar. Remove split pin, washer and contact bar from plunger pin. Install new contact bar on plunger pin, then install washer and split pin. Test points for proper operation, then install cover.

TELL-TALE LIGHTS AND RESISTORS

Tell-tale lights are employed to signal the operator of various conditions, some of which

demand immediate attention. Some of these lights have a resistance unit connected in the circuit to insure operation under all conditions.

Refer to gauge panel (fig. 3) for location and identification of tell-tale and resistors, also to wiring diagram (fig. 1) for individual circuits.

ELECTRICAL SPEEDOMETER

The electric speedometer consists of a transmitter, head and connecting electrical wires.

The transmitter is mounted on and driven by the transmission. As the transmission rotates the transmitter rotor a three-phase alternating current is induced and transmitted to the head through the wiring. The frequency of this current varies with the speed of the transmission, thus the speed of the rotor in the head is precisely that of the transmitter rotor.

Rotation of the head rotor is transmitted to the speedometer dial pointer to visually record the speed of vehicle in miles per hour.

Testing

If a system becomes inoperative or is not operating properly the following checks should be made.

1. Check the continuity of external wires from plug to plug for possible open circuits or shorts.
2. Check the electrical resistance between any two terminals of transmitter. Resistance between terminals should be between 13-1/2 - 16-1/2 ohms.
3. Check electrical resistance between any two terminals of head. Resistance between terminals should be between 25-1/2 - 31-1/2 ohms.
4. Failure to obtain specified resistance values indicates that unit is damaged internally and should be replaced.

SPECIFICATIONS

Fuses

Master (Eng. Comp. Panel) (Amp's.)	150
Starter Circuit (Engine Comp. Panel) (Amp's.)	20
Engine Compartment Lights (Eng. Comp. Panel) (Amp's.)	20
Air Conditioning Blowers (Buzzer Panel) (Amp's.)	20
Miscellaneous (Fuse Panel)	Refer to "Fuse Panel" Tabulation in this Section also to Wiring Diagram.

Resistors

Low Air Tell-Tale	5 Ohms
Emergency Door Tell-Tale	5 Ohms
Low Oil Tell-Tale	6 Ohms
Water Overheat Tell-Tale	6 Ohms
Oil & Water Temperature Gauges	6 Ohms
Low Oil & Water Overheat	10 Ohms

Horn

Make	Delco-Remy
Model	1999700
Voltage	12
Air Gap	0.030" — 0.034"
Current	3.5 - 5.5
Frequency	300 - 320

Horn Relay

Make	Delco-Remy
Model	1116818
Air Gap (Points Closed)	0.020"
Point Opening	0.030"
Armature Attracted (Volts)	6.0 - 8.0

Low Air Pressure Indicator

Make	Bendix-Westinghouse
Model	076218
Contacts Close (Lbs.)	54 - 66

WIRING AND MISC. ELEC.

SPECIFICATIONS (Cont'd)

Tell-Tale Alarm Buzzer Relay

Make	Delco-Remy
Model	1116775
Air Gap (Points Closed)	0.015"
Point Opening	0.025"
Armature Attracted (Volts)	2.75 - 4.0

Low Oil Pressure Switch

Make	AC
Model	1506714
Contacts Break (Lbs. Pressure)	2 - 4

Water Overheat Thermostat

Make	Kysor
Model	Z-2373
Temperature Setting	212°F.

Moto-Gard

Make	Moto-Gard
Model	12-D

Moto-Gard Cut-Out Switch

Make	Nat'l. Pneumatic
Model	C-19720

Moto-Gard and Tell-Tale Alarm Relay

Make	Cutler-Hammer
Model	6041-H-47
Type	Single Throw Double Pole
Amperage	50
Voltage	12
Coil Data	
Resistance (Ohms)	16.0
Current (Amps)	.75
Pick-up & Close (Volts)	10
Drop Out & Open (Volts)	4.5

Electric Speedometer

Make	Eclipse-Pioneer
Model	
Transmitter	2276-1-A
Head	2232-12A-A

Battery

Contents of This Section

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The battery is an electro-chemical device for storing electrical energy, and when properly used, has two major functions. The first function is to govern, directly, the voltage of vehicle's electrical system. The second function is to provide electrical energy to starter while engine is being started. The battery also supplies energy, under limited conditions, to lights and other accessories.

The battery consists of six cells connected in series, giving a terminal voltage of twelve volts. Each cell is made up of an acid-proof compartment in which two groups of plates, positive and negative, are immersed in electrolyte, a solution of sulphuric acid and water.

The battery delivers energy when it is connected to an electrical circuit. This energy is derived from chemical reaction of sulphuric acid in the electrolyte and active materials in plates. During course of energy-producing reactions, sulphuric acid is absorbed and water produced, thus decreasing specific gravity of electrolyte.

After reaction between plates and electrolyte has continued for a considerable length of time, amount of available acid is so small as to prevent further delivery of useful energy, and battery is said to be discharged.

The generator is designed to restore to battery, energy consumed in starting, and then to assume burden of supplying complete electrical load. If generator fails in its duty and battery becomes run-down, charging from an outside source is necessary.

MAINTENANCE

Batteries are located in a battery compartment on left hand side of vehicle. Accessibility is through a door in body side panel.

Battery should be inspected and checked at least once a week. Inspection should include battery hold-down clamps, terminals, and electrolyte level. Each cell should be checked with an accurate hydrometer.

Battery terminals should be checked at periodic intervals. Remove all corrosion deposits, using a solution of ammonia in water. Coat terminals with petrolatum before tightening. Check battery ground strap and cable to starter, and replace when necessary.

Add pure (preferably distilled) water to each cell until water level is approximately 3/8 inch above plates. Do not overfill cells. Water should be added just before a run because unmixed water may freeze in cold weather.

Test each cell with an accurate hydrometer for specific gravity. The specific gravity indicates state of battery charge. The reading on fully-charged battery should be between 1.275 and 1.300. When reading is below 1.225 battery should be removed and recharged.

Freezing point of electrolyte depends on its specific gravity and condition of battery charge. Following table gives freezing temperatures of battery solution at various specific gravities:

Specific Gravity	Freeze Temp. Deg. F.	Specific Gravity	Freeze Temp. Deg. F.
1.100	+18	1.220	-31
1.120	+14	1.240	-51
1.140	+ 8	1.260	-75
1.160	+ 2	1.280	-92
1.180	- 6	1.300	-95
1.200	-17		

BATTERY

TESTING

Test each cell with an accurate hydrometer for specific gravity. The specific gravity indicates state of battery charge. The reading on a fully-charged battery should be between 1.275 and 1.300 at 60°F. When reading is below 1.225 battery should be recharged.

Battery may be tested with conventional testing instruments. These instruments, if used as manufacturer directs, will indicate conditions of battery prior to recharging or repairing.

Battery should be recharged with standard equipment. Do not bring an open flame near battery during charging, as explosive gases form in cells during this operation.

Testing cell voltage in connection with specific gravity test will give a good indication of battery condition. Battery must test higher than 1.240 and battery, engine, and starter must be at normal room temperature, otherwise test will not be accurate.

Operate starter and quickly check each cell of battery with low reading voltmeter. To prevent engine starting, hold stop switch button in. If voltage reading is less than 1.7 volts at 80°F, or if there is a difference between cell readings of more than 0.1 volt, battery trouble is indicated and battery should be removed for further check.

BATTERY CABLES

Check cable leads and connections to determine if they are in good condition. Excessive resistance, generally caused by poor connections, produces abnormal voltage drop which may lower voltage at starting motor to such a low value that normal operation of starting motor will not be obtained. Abnormal voltage drop can be detected with a low reading voltmeter as follows:

1. Check voltage drop between grounded battery terminal (positive) and vehicle frame. Place one prod of voltmeter on battery terminal and other on vehicle frame. With starting motor cranking engine at normal room temperature (70°F) voltage reading should be less than 0.3 volt. If more than this, there is excessive resistance in this circuit.

2. Check voltage drop between ungrounded battery terminal (negative) and starting motor terminal stud while motor is operated. If reading is more than one volt, there is excessive resistance in circuit.

NOTE: If necessary to extend wire from meter for this test, use No. 16 or larger wire.

3. Check voltage drop between starting motor housing and vehicle frame. This must be less than 0.1 volt.

CAUTION: When working on engine, precautions should be taken to prevent accidental starting of engine. Make certain that starter circuit cut-out switch is "OFF."

SPECIFICATIONS

Make	Exide
Model	6LXWG-17-3R
Voltage	12
Plates Per Cell	17
Ampere Hour (Each Battery)	126 @ 6 Hr. Rate
Quantity	Two, Connected in Parallel
Specific Gravity - Fully Charged	1.275 - 1.300
Recharged @	1.225

Starting System

Contents of This Section

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This section includes service information on units used in the starting system of models covered by this manual. The starters are identified by model numbers stamped on a plate attached to starter housing. Solenoids and relays are identified by a number stamped in the mounting bracket. Refer to "Specifications" later in this section for service data and model application.

The starting system includes battery, starter, solenoid, starter relay, starter control relay, starter buttons, cut-out switch, fuses and wiring.

Source of energy for operation of starting system is the battery, which is described in "Battery," (Sec. 7B of this manual).

Starting system is protected by two fuses, one of which is located behind instrument panel and the other on engine compartment panel.

Starting system circuits are shown on wiring diagrams in Wiring (Sec. 7A of this manual).

7

OPERATION AND CONTROLS

The starting system operation is dependent upon the function of each unit included in the system. Method of operating controls is fully described in "Operation" (Sec. O of this manual).

STARTER SOLENOID

Starter solenoid is used to shift starting motor pinion into mesh with flywheel ring gear and close the starting motor circuit causing motor to crank engine. Pressing starter button operates relays to complete starting motor circuit and energize solenoid. Solenoid is mounted on starting motor frame and plunger is connected by linkage to pinion shift lever. When solenoid is energized plunger pulls pinion into mesh with flywheel ring gear teeth. Plunger movement then continues, closing switch contacts and completing starting motor circuit. Starting motor then cranks engine.

Solenoid has two coils. The pulling coil draws comparatively heavy current for a short interval. This is needed to engage the pinion. The holding coil also aids the pulling coil. As soon as solenoid plunger completes starting motor circuit, pulling coil is de-energized by action of contact points and only holding coil draws current.

STARTER SOLENOID RELAY

Starter solenoid relay is used in conjunction with starter solenoid to magnetically shift starting motor pinion into mesh with flywheel ring gear and close the starting motor circuit. Pressing starter button closes relay circuit and energizes relay coil to close the contact points. This completes the solenoid circuit, solenoid magnetically shifts starting motor pinion and at the same time closes starting motor circuit causing motor to crank engine.

STARTER CUT-OUT RELAY

A starter cut-out relay is used in circuit between generator and starter solenoid relay. When generator is charging, relay coil is energized and contact points of relay are opened. This breaks starter relay circuit which is grounded through the starter cut-out relay and makes it impossible to close starter solenoid circuit and shift starting motor pinion to engage flywheel ring gear while engine is running.

STARTER CUT-OUT SWITCH

Switch is located on engine compartment control box panel and is used as a safety device to prevent accidental starting of engine while

STARTING SYSTEM

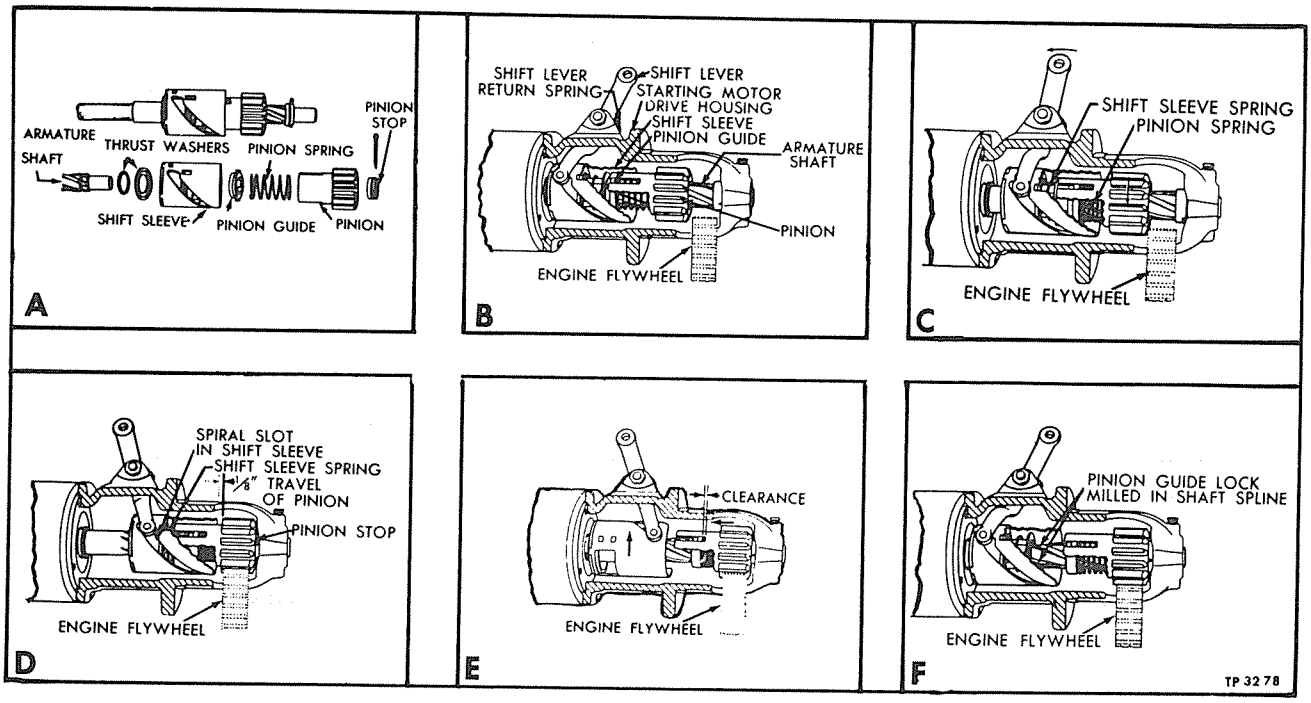


Figure 1—Dyer Drive Operating Positions

mechanic is servicing power plant. ALWAYS TURN SWITCH TO "OFF" POSITION WHEN SERVICING ENGINE.

STARTER SWITCH BUTTON

Two switches are used, one at instrument panel and other in engine compartment. These switches are inoperative while starter cut-out switch in engine compartment is "off" or when generator is charging so that starter control relay cuts out starting motor circuit.

STARTER DRIVE MECHANISM

The pinion meshes with flywheel by means of solenoid operated sleeve as previously described. The shift lever on starter is connected by linkage to solenoid. Return spring is used to hold shift lever in released position when not in use.

The detailed action of drive can be followed by referring to figure 1 and accompanying explanation. Each illustration represents a position or step through which drive assembly passes in a complete cranking operation. The drive housing, shift sleeve, and pinion are cut away showing action of parts. The engine flywheel is shown so that relative action of drive with flywheel can be noted.

At Rest Position (B, Fig. 1)

In the "At Rest" position, pinion is held away from flywheel by locking action of pinion guide and pinion spring in milled portion of the shaft spline. Refer to F, figure 1. The engine may, or may not, be in operation when drive is in this position. It is impossible for pinion to drift into flywheel when it is in this locked position.

Beginning of Engagement (C, Fig. 1)

The engine is "dead" and cranking operation has begun. As shift lever moves shift sleeve towards flywheel, pinion guide is unlocked from milled portion of spline by pressure of inner sleeve on guide. This action allows pinion to reach flywheel. If relative position of flywheel and pinion is such that teeth match, meshing will take place immediately. If teeth butt engagement, pinion is further rotated in its movement towards flywheel until it reaches position for meshing. Compression of inner coil spring against pinion guide compensates for continued movement of shift lever and shift sleeve.

Engagement Action Complete (D, Fig. 1)

When pinion has been rotated to proper position for engagement, action is completed by further movement of shift lever and action of pinion spring. The pinion stop limits travel of pinion. When meshing of pinion with flywheel is completed, further movement of shift lever closes starting motor switch contacts.

Operating Position (E, Fig. 1)

As starting motor begins to crank engine shift sleeve is carried back to its original position by rotation of armature shaft and sleeve moves back and rotates as indicated by arrow. It is rotated by action of stud in shift lever and

spiral slot in shift sleeve. When engine fires, accelerating action disengages pinion from flywheel and pinion returns to locked or "at rest" position.

It is impossible to start another cranking operation until complete cranking cycle is finished. After engine fires, shift lever should be allowed to return to "at rest" position and unit is then ready for another cranking operation.

It is impossible to engage pinion while engine is running, for, as soon as pinion teeth touch moving flywheel teeth, shift sleeve is rotated and pinion follows armature shaft spline back to locked position (F, fig. 1).

Relative Position of Parts (F, Fig. 1)

This illustration does not represent a step in actual cranking operation, but merely shows position of the lock in shaft spline.

The engagement movement of shift lever is always against tension of shift lever return spring (B, fig. 1). When a cranking operation is completed, and shift lever is returned, continued tension of shift lever return spring creates a force on armature assembly towards commutator end of starting motor. This force is transmitted through armature brake directly against brake washer in commutator end of motor. The force of brake against brake washer stops armature almost immediately after shift lever is allowed to return. This feature makes starting motor immediately ready for another cranking operation in case engine does not continue to operate after it fires.

STARTERS

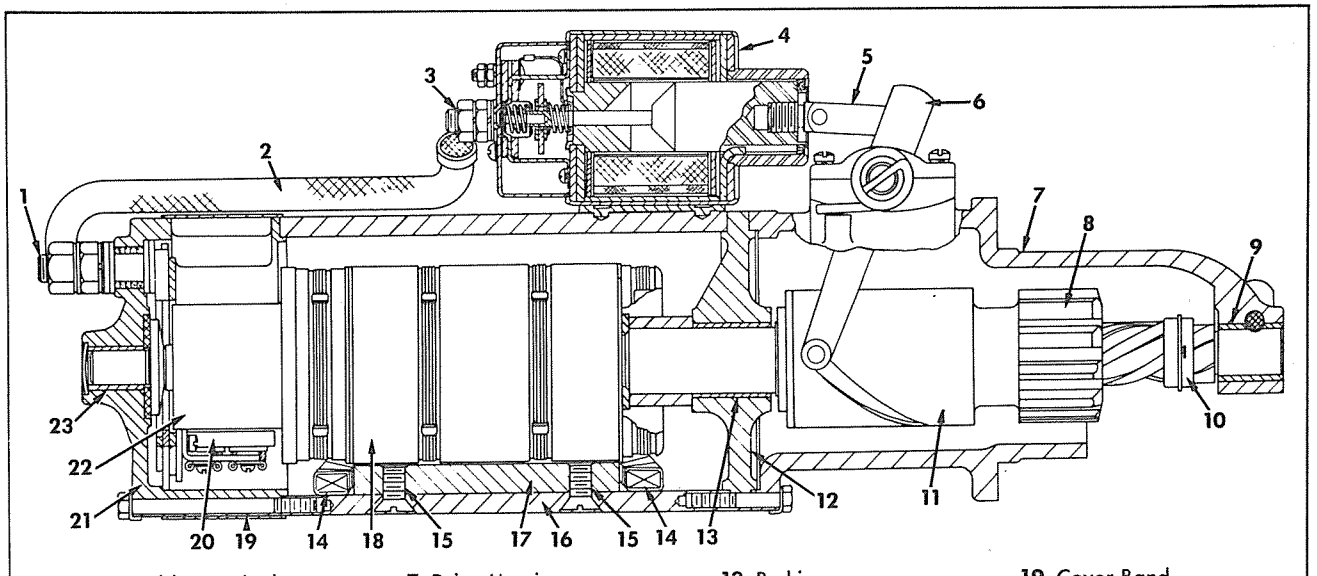
Starter, illustrated in figure 2, is solenoid operated "Dyer Drive" type. Solenoid, relays and shift mechanism operation are described under "Controls and Operation" previously in this section, also refer to "Operation" (Sec. O of this manual).

INSPECTION AND MAINTENANCE (ON VEHICLE)

Normal service may be obtained from starter with a minimum of trouble if regular lubrication, inspection and maintenance procedures are followed.

CLEANING

Exterior as well as the interior of the starter should be kept clean. Use a clean cloth dampened with cleaning solvent to wipe off excess grease. Do not steam clean or dip starter and avoid getting any water or cleaner in the starter. If interior of starter is dirty, remove, disassemble and clean all parts individually.

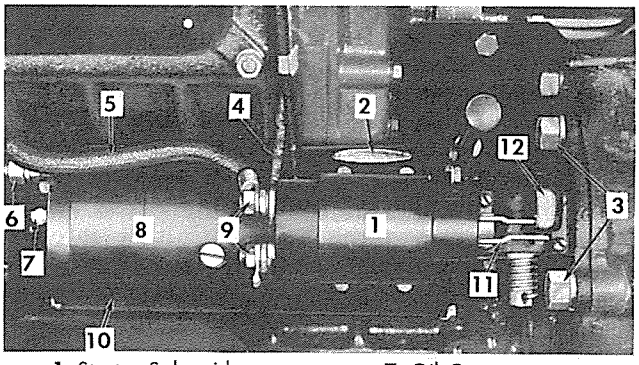


1 Starter Cable Terminal
2 Cable
3 Solenoid Cable Terminal
4 Starter Solenoid
5 Shift Link
6 Shift Lever
7 Drive Housing
8 Pinion
9 Bushing
10 Pinion Stop
11 Dyer Drive Assembly
12 Center Plate
13 Bushing
14 Field Coil
15 Pole Shoe Screw
16 Field Housing
17 Pole Shoe
18 Armature
19 Cover Band
20 Brush
21 Commutator End Frame
22 Commutator
23 Bushing

TP 1671-1

Figure 2—Sectional View of Starter

STARTING SYSTEM



1 Starter Solenoid
2 Name Plate
3 Attaching Stud Nuts
4 Battery Lead Wire
5 Solenoid to Starter Wire
6 Starter Terminal
7 Oil Cup
8 Starter
9 Solenoid Terminals
10 Cover Band
11 Shift Link
12 Shift Lever

TP 1961

Figure 3—Starter Installed

COMMUTATOR

The cover band should be removed and commutator inspected at 5,000 mile intervals. If commutator is dirty, clean with strip of No. 00 sandpaper - DO NOT USE EMERY CLOTH. All dust must be blown from starter after commutator has been cleaned.

BRUSHES

Replace worn brushes. Brushes may be seated by use of a brush seating hone. With starter operating at medium speed, press hone firmly against commutator to cover area contacted by brushes. Brushes should seat satisfactorily in a short period. Blow starter out with compressed air after using hone to remove all particles of abrasive. Do not use emery cloth or sandpaper to seat brushes. Check pigtail lead connections to be sure they are tight.

Brush Spring Tension

Check brush spring tension. Excessive spring tension will cause commutator and brushes to wear rapidly. Low spring tension will cause a reduced starter speed, also arcing and burning of commutator and brushes. Replace springs if tension is not as listed in "Specifications" later in this section.

MISCELLANEOUS

Make careful inspection of wires, terminals and all visible parts of starter. Any apparent defects should be corrected immediately.

Unusual noises in the starter may be caused by loose mountings. Worn or dirty bushings may cause noise or slow starter speeds and require cleaning and lubrication or, if worn excessively, replacement. Improperly seating brushes may cause slow starter speeds. Brushes can be reseated as previously explained under "Brushes" in this section. Bent brush holders should be replaced.

REMOVAL

1. Remove battery cable from solenoid terminal (fig. 3) and tape end to prevent accidental short and discharge of battery, or preferably disconnect ground cable at battery.

2. Remove three stud nuts attaching starter to flywheel housing. Move starter straight away from housing to complete removal.

BENCH TESTS

If starter does not operate properly, it should be removed from vehicle and tested on bench to localize trouble. Two bench tests - No-Load and Torque - should be made to determine condition of unit before disassembly.

NO-LOAD TEST

Connect the starter in series to a battery of the correct voltage and an ammeter capable of reading high amperage. If available, also connect a revolution counter. Note the revolutions and amperage draw with the starter running at free speed or no-load.

TORQUE TEST

If available, install starter in suitable test equipment to conduct stall test. The torque developed, current draw and voltage required should be noted.

Interpretation of No-Load and Torque Tests

Rated torque, current draw and no-load speed are listed in "Specifications" at end of this section. Interpretation of tests are as follows:

1. Low Free Speed and High Current Draw With Low Torque - May Result From:

a. Dirty, tight or worn bushings. Bent armature shaft or loose field coils and pole shoes.

b. Shorted armature. Check armature on growler after disassembly as instructed later under "Testing Parts" later in this section.

c. Grounded armature or field. Check by raising grounded brushes from commutator or disconnecting grounded connections where field is grounded by screws inside starter and testing with test light and points from starter terminal and housing, also from commutator to housing. If the test lamp lights, a ground exists.

2. Failure to Operate With High-Current Draw Indicates:

a. A direct ground in switch, terminals or brushes.

b. Seized bushings which prevent armature turning.

3. Failure to Operated With No-Current Draw Indicates:

a. Open field circuit. Inspect internal connections and trace circuit with test light.

b. Open armature coils. Check as later directed under "Testing Parts" in this section.

c. Broken or weakened brush springs, worn brushes, high commutator mica or other conditions which prevent good contact between brushes and commutator.

4. Low No-Load Speed With Low Torque and Low Current Draw Indicates:

a. Open-field winding. Raise and insulate ungrounded brushes from commutator and check fields with test light.

b. High internal resistance, due to poor connections, defective leads, dirty commutator, weak or broken brush springs and other causes that would produce poor contact between commutator and brushes.

c. Defective leads, broken or loose connections.

5. High Free Speed With Low Torque and High Current Draw Indicates:

a. Shorted fields. There is no easy way to detect shorted fields, since field resistance is already low. If shorted fields are suspected, replace the fields and check for improvement in performance.

DRIVE MECHANISM ADJUSTMENT

The drive is properly adjusted before leaving the factory.

When shift lever is in extreme forward position and switch contacts in solenoid are closed, there should be at least 1/8 to 3/16 inch travel of pinion against pinion spring pressure as indicated (fig. 1, D). This adjustment can be checked easily by disconnecting lead from solenoid to starting motor and using battery current through solenoid to hold shift lever in forward position. Since disconnecting this lead opens pull-in coil of the solenoid, it may be necessary to assist movement of plunger by hand to assure that plunger will reach its extreme travel position, closing the switch contacts. The starting motor armature will not revolve with this lead disconnected. The pinion travel can be checked by pushing pinion back against spring pressure. The adjustment can be changed by turning plunger stud in or out of solenoid plunger as necessary.

A test can be made to determine if engagement action is being completed before switch contacts are closed. This can be done by placing a 9/16 inch spacer between pinion and pinion stop. The shift lever can be moved forward then, forcing pinion against the spacer. It should not be possible to close switch contacts with spacer inserted. This adjustment can be changed by adjusting plunger stud as mentioned above.

When pinion is in operating position (fig. 1 E), there should be 1/32 inch clearance between pinion guide and bottom of slot at point indicated. If there is no clearance at this point, drive will be taken directly from hubs on pinion guide rather than from heavy spline in pinion itself. If it is found that there is no clearance at this point, the pinion and pinion guide should be replaced. The pinion with its lock and lock spring is released by moving pinion shift sleeve forward and along splines of shaft.

In assembling parts, pinion lock lugs should be in slots in the pinion hub with lugs toward pinion, or it will not be in the proper position to lock on the shaft.

DISASSEMBLY

1. Remove cable between solenoid and starter. Remove cotter pin and clevis pin attaching solenoid linkage to shift lever. Remove cap screws and lock washers attaching solenoid to housing, then remove solenoid.

2. Remove cap screws and lock washers attaching drive housing to starter housing. If necessary, tap housing with soft hammer to loosen then remove field housing from drive housing and armature.

3. Remove brush cover band by unsnapping catch. Note relationship of brush leads and brushes for reassembly purposes. Disconnect leads from field coil conductors. Remove cap screws and lock washers attaching commutator end frame to field housing, then separate these two parts. If necessary, tap with soft hammer to loosen while separating.

4. Remove nuts and washers from insulated terminal. Remove screws and lock washers attaching brush plate assembly to commutator end frame. Note position of insulators and washers for reassembly purposes. Remove brushes, springs and spring holders.

5. Remove shift lever assembly cover attaching screws and lock washers. Remove cover, shift lever shaft and return spring assembly.

6. Remove cotter pin attaching pinion stop to armature shaft. As armature is being removed from drive housing, slide pinion stop, pinion, pinion spring, guide, sleeve, and two thrust washers from armature shaft. Slide spacer and center bearing from armature shaft.

7. Remove field coils from field housing by removing pole shoe screws with pole shoe screw-

STARTING SYSTEM

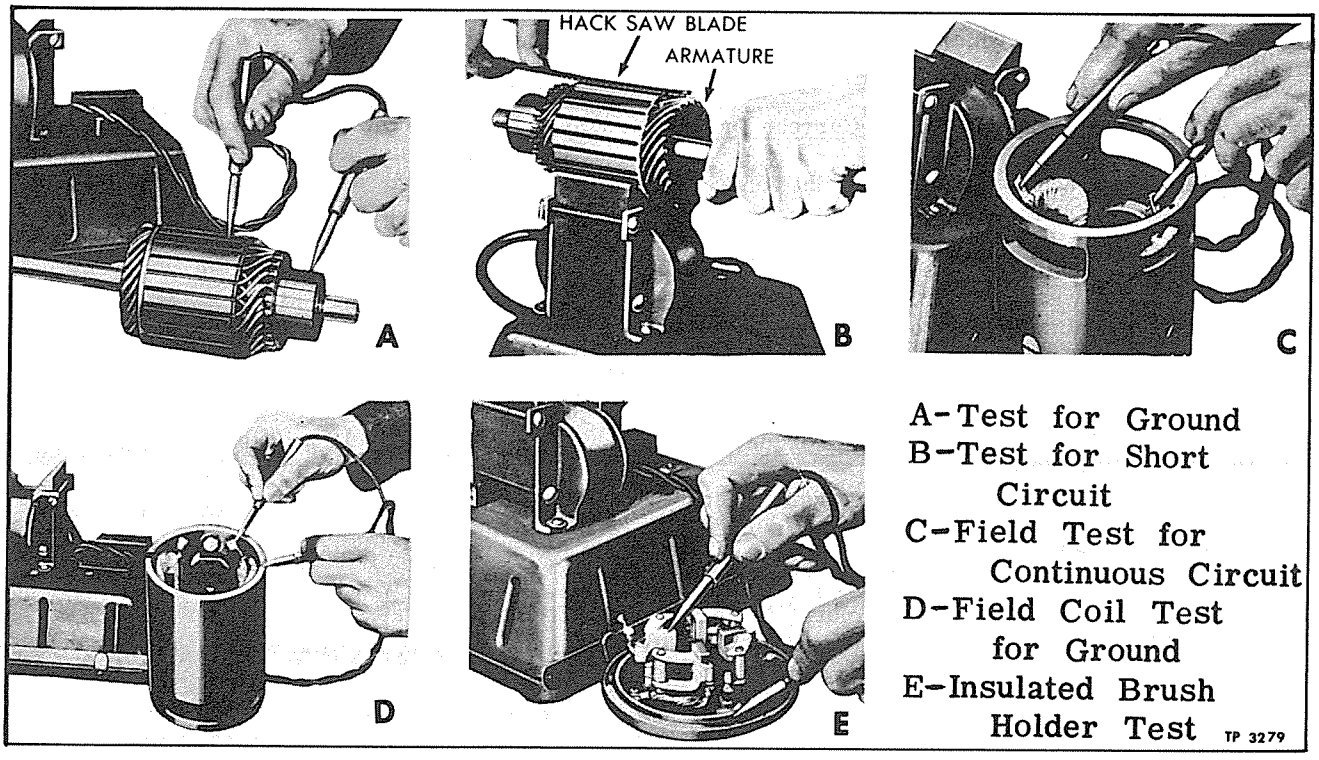


Figure 4—Starter Tests

driver. Remove pole shoes and field coils. Note position of insulating strips, if used, so they can be replaced in their correct location at time of reassembly.

INSPECTION

CLEANING

All parts, except field coils and armature, should be washed in cleaning solvent. Field coils and armature should be wiped clean with a rag.

ARMATURE

Check armature to commutator leads to be sure they are properly soldered. Loose leads should be resoldered as directed under "Repair" later in this section.

COMMUTATOR

Inspect commutator and if found to be rough, out-of-round, worn or has high mica, filled slots or is burned, it must be replaced or repaired as directed under "Repair" later in this section.

FIELD COILS

Use care in handling the coil assembly to avoid breaking or weakening the connecting straps between windings. The field insulation must be in good condition. If insulation is carcked, charred or worn so that windings are exposed, it is sometimes possible to repair them as directed under "Repair" later in this section.

BRUSHES

If brushes are worn down to less than half their original length, they must be replaced. Be sure that pigtail leads are secure in the brushes and that clips are properly soldered to the leads.

Brush Springs

Brush springs must have sufficient tension to provide proper pressure between brushes and commutator after the generator is reassembled. Replace springs if damaged or if tension is not as shown in "Specifications" later in this section.

Brush Holders

Carefully examine brush arms, arm pins, and holders for bent, warped or damaged condition. Any condition that might interfere with proper brush action should be corrected.

BUSHINGS

Carefully inspect bushings for evidence of wear. Install armature shaft into bushings and check clearance between bushings and shaft. If clearance is excessive, replace bushings as directed under "Repair" later in this section.

DYER DRIVE

Carefully inspect all parts of Dyer Drive for wear or other damage. Check spring for broken or weakened coils. Inspect pinion for worn or chipped teeth or splines.

MISCELLANEOUS

Carefully inspect insulators and insulating washers for damage or burned condition. Inspect all studs or screws for bent or damaged condition and cross threads.

TESTING PARTS

Starter parts may be tested with suitable electrical testing equipment. Illustrations showing application of test equipment are merely typical. Instructions furnished by manufacturer of test instruments used should be followed.

ARMATURE

Following armature tests should always be made while starter is disassembled.

Ground

Use conventional test light and prods and place one test prod on armature and other to commutator (fig. 4, A). If test light lights, armature is grounded and should be replaced, if defect is not readily apparent and repairable.

Open Circuited

An open circuit in the armature usually results in badly burned commutator bars and can be easily detected visually. If the bars are not badly burned, they can sometimes be corrected as directed under "Repair" later in this section.

Short Circuited

Place armature on growler connected to alternating current. Hold hack saw blade over armature while armature is rotated slowly (fig. 4, B). If saw blade vibrates or buzzes, it indicates that armature is short circuited. Before replacing an armature that is apparently shorted, inspect the commutator slots for copper or brush dust deposits. Clean thoroughly and again test.

FIELD COILS

Following field coil tests should be made while coils are installed in place in housing.

Continuous Circuit. Place test prods on field coil leads (fig. 4,C). If light does not light, field coils are open circuited and should be replaced.

Ground. Place one test prod on starter housing and other on field coil leads (fig. 4, D). If lamp lights, coils are grounded and should be replaced. When above test indicates that there is a ground in field coils, individual tests should be made to determine which coil is grounded. Break connection between coils and test each one separately.

TERMINAL TEST

Ground. Place one test prod on terminal and one on frame of starter. If test lamp lights, terminal insulation is broken and should be replaced.

BRUSH HOLDER TEST

Place one test prod on insulated brush holder and other on end frame (fig. 4, E). If test lamp lights, brush holder is grounded and hinge pin, insulation and stop pin should be replaced.

REPAIR

COMMUTATOR

Turning Down. Place armature in lathe and turn down to remove worn spots, out-of-round, rough or worn condition. Do not cut off more than necessary. If ends of commutator segments are less than 1/16" wide, the armature must be replaced.

Under Cut Mica. Mica between segments must be below the edge of segment. Start groove with a small three-cornered file, then use hack saw blade to undercut the mica until it is 1/32" below segment. Use No. 00 sandpaper to clean and smooth up commutator, then use compressed air to remove all fine particles of cuttings.

ARMATURE

Resoldering. When commutator riser bars are burned, this is often caused by an open-circuited armature. When the bars are not too badly burned, the armature can sometimes be saved by resoldering the leads in the riser bars, using rosin flux. After soldering turn down the commutator and undercut the mica.

FIELD COILS

Insulation. If the insulation is worn, so that the field wiring could become grounded, it can sometimes be repaired by rewrapping the field coils. Rewrapping must be done with extreme care and neatness, as excessive wrapping may hinder reassembling.

Connections. If connections between coils are loose, they can be resoldered. Always use rosin flux when soldering electrical connections; never use acid flux.

BUSHINGS

Removal. Remove oil wick from lubricant passage. Use arbor press to remove worn bushings from commutator end frame, center support and drive end housing.

Installation. Use arbor press to install new bushings and ream to provide running clearance to shaft. Drill oil hole through one wall of bushing. Install new oil wick in lubricant passage.

STARTING SYSTEM

REASSEMBLY

1. Install field coils and pole shoes in field housing using new insulation strips if used in same location as found at time of disassembly. Tighten pole shoe screws.

2. Install collar and center bearing assembly over armature shaft.

3. Place plain thrust washer and cupped thrust washer on armature shaft with cupped section of washer toward end of armature shaft. Position shift sleeve, pinion guide, spring and pinion on armature shaft. Pinion guide lugs must be toward the pinion. Align pinion guide lugs with slots in the skirt. of the pinion. Hold pinion guide with thumb and fore-finger. Push pinion onto shaft, compressing the spring, until lugs are about midway of pinion slots then rotate the pinion and pinion guide onto the armature shaft splines. Continue twisting pinion until a click is heard which indicates that the pinion guide is locked in the undercut portion of the armature shaft and retains the entire assembly. Install the pinion stop on the armature shaft, align holes and install cotter pin, being sure cotter pin is bent over as far as possible.

4. Position armature shaft in drive end housing. Attach center bearing assembly to drive end housing with attaching bolts and install lockwire (if used) through bolt heads to prevent loosening.

5. Install shift lever and cover to drive housing, being sure end of lever is in circular slot of shift sleeve. Place spring on shift lever shaft with long tang on drive end frame boss. Twist spring and drop into slot in end of shaft. Position field housing against drive end housing as indicated by location of oiler on field housing. Install cap screws and lock washers attaching field housing to drive housing and tighten securely.

6. Assembly brush holders, brushes, insulating washers, etc., to commutator end frame in same position as noted at time of disassembly. Be sure all connections are tight and that insulators are properly located.

7. Locate commutator end frame against field housing with all others in alignment. Attach with cap screws and lock washers. Connect field coil leads and brush lead clips to brush holders.

8. Install solenoid to field housing and connect linkage to shift lever. Connect cable between solenoid and starter terminal.

9. Adjust linkage between solenoid and shift lever to provide proper clearances as directed in "Bench Tests" under "Drive Mechanism Adjustment" previously in this section.

INSTALLATION

1. Locate starter in position against flywheel housing. Install three stud nuts, using lock washers. Tighten cap screws or nuts evenly and alternately until tight.

2. Attach battery and solenoid cables to starter solenoid, there tighten terminal nuts.

STARTER SOLENOID AND RELAYS

Operation of starter is controlled by starter button, solenoid and relays, each of which performs a specific function. Refer to "Operation and Controls" previously in this section for specific purpose, description and operation for each of these control units. In addition, refer to "Operation" (Sec. O of this manual) for proper usage of the two starter buttons.

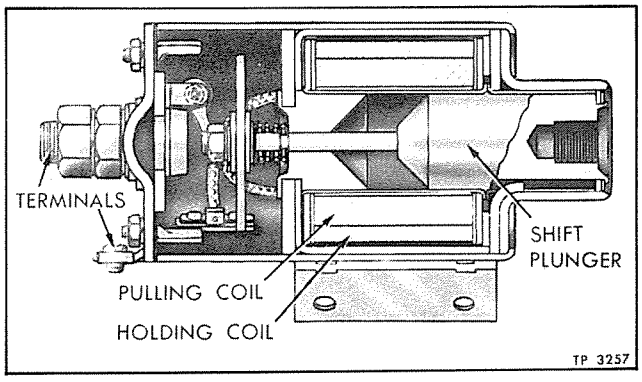


Figure 5—Starter Solenoid

SOLENOID

Solenoid (fig. 5) is mounted on starter housing as shown in figure 3. Operation of solenoid is fully explained under "Operation and Controls" previously in this section.

Maintenance

Solenoid requires no maintenance other than keeping contact points and terminals clean and tight. Always check action of solenoid if it has been removed and reinstalled. If unit fails to function, first check switches, relay and wiring before working on solenoid. Only test to make on solenoids is to check pull of solenoid coils with suitable equipment. Refer to "Specifications" later in this section for test data.

STARTER SOLENOID RELAY

The starter solenoid (fig. 6) is mounted on engine compartment panel located inside the baggage compartment at rear of vehicle. Refer to

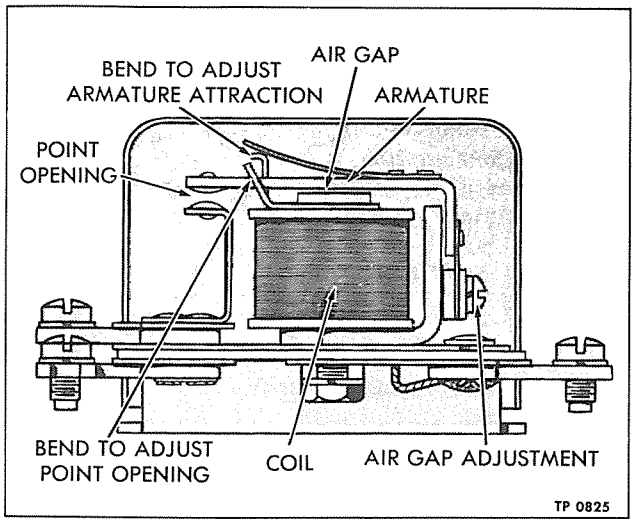


Figure 6—Starter Solenoid Relay

Wiring (Sec. 7A of this manual for wiring connections. Maintenance and adjustment operations are given below. Remove snap-on cover from relay to gain access to unit.

Air Gap Adjustment

With the contact points held closed, measure the air gap between the armature and center of coil. Adjust air gap by loosening two screws and move armature up or down as required (fig. 6). If necessary, align the support carrying the lower contact so that air gap will be uniform between the coil and the armature. Refer to "Specifications" later in this section, for correct air gap dimension.

Point Opening Adjustment

Measure the contact point opening with the armature in the open position. Adjust by bending armature stop (fig. 6). Refer to "Specifications" later in this section, for correct point opening dimension.

Closing Voltage Adjustment

With original leads connected to relay terminals, connect an accurate reading voltmeter at the relay terminals in parallel with the circuit. To check closing voltage, insert a variable resistance of 10 ohms (resistance should be capable of carrying 1 ampere) in series in relay circuit from battery. With push button switch pressed in, adjust resistance until the relay points close and note voltmeter reading. Adjust by bending armature spring to increase or decrease tension on armature (fig. 6). Increasing tension increases closing voltage and decreasing tension decreases closing voltage.

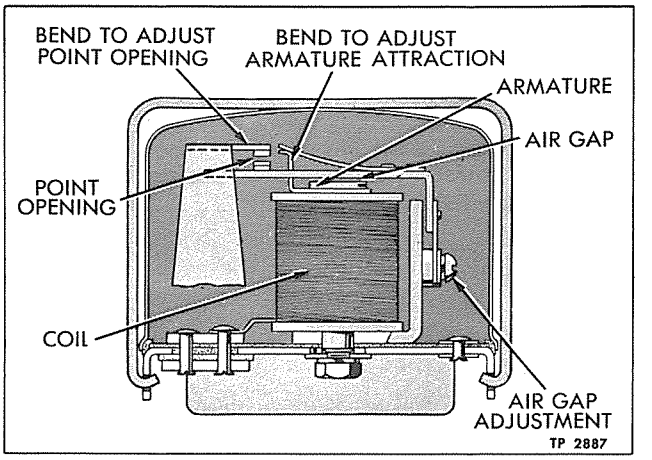


Figure 7—Starter Cut-out Relay

STARTER CUT-OUT RELAY

Starter cut-out relay (fig. 7) is mounted on engine compartment panel located inside the baggage compartment at rear of vehicle. Refer to Wiring (Sec. 7A of this manual) for wire and terminal connections. Maintenance and adjustment operations are given below. Release wire clamp for removal of cover to gain access to relay.

Air Gap Adjustment

Since relay is constructed so that contact points are normally closed, air gap adjustment as originally set should not require later adjustment. Position of armature can be changed, however, by loosening the screws and moving armature up and down as desired (fig. 7). Refer to "Specifications" later in this section, for correct air gap dimension.

Point Opening Adjustment

Measure the contact point opening with the armature in the down position. Refer to "Specifications" later in this section, for proper opening dimension. Adjust point opening by bending the support carrying the upper contact point (fig. 7). Clean contact points with a thin, fine-cut file if pitted or burned.

Opening Voltage Adjustment

Connect accurate reading voltmeter to the relay terminal marked "Gen" and to a convenient ground. Start the engine and gradually increase the speed until the contact points open. This is the opening voltage of the relay and it can be adjusted by increasing or decreasing the armature spring tension to obtain correct opening voltage (fig. 7). Refer to "Specifications" later in this section for correct opening voltage.

STARTING SYSTEM

SPECIFICATIONS

STARTER

Make	Delco-Remy
Number	1108735
Rotation - Viewed at Drive End	Counterclockwise
Brush Spring Tension	36-40 Ozs.

No-Load Test

Amperes	100
Volts	11.6
R.P.M.	5000

Lock Test

Amperes	570
Volts	2.3
Torque - Ft. Lbs.	20

STARTER SOLENOID

Make	Delco-Remy
Number	1118171
Max. Volts to Close @ 70°F	10.0
Air Gap	0.5"
Pounds Tension (Pull)	70
Current Consumption	
Both Windings @ 10 Volts	50.0 - 53.0 Amps.
Hold-in Winding @ 10 Volts	13.0 - 14.0 Amps.

STARTER SOLENOID RELAY

Make	Delco-Remy
Number	1850505(264-G)
Air Gap (With Points Closed)	0.012"
Point Opening	0.035"
Armature Attracted (Max. Volts	8.5
Armature Released (Volts)	3.5 - 4.2

STARTER CUT-OUT RELAY

Make	Delco-Remy
Number	1116757
Point Opening	0.030"
Armature Attracted (Max. Volts)	8 - 10

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference—Make note of bulletin number in space below:

NOTES

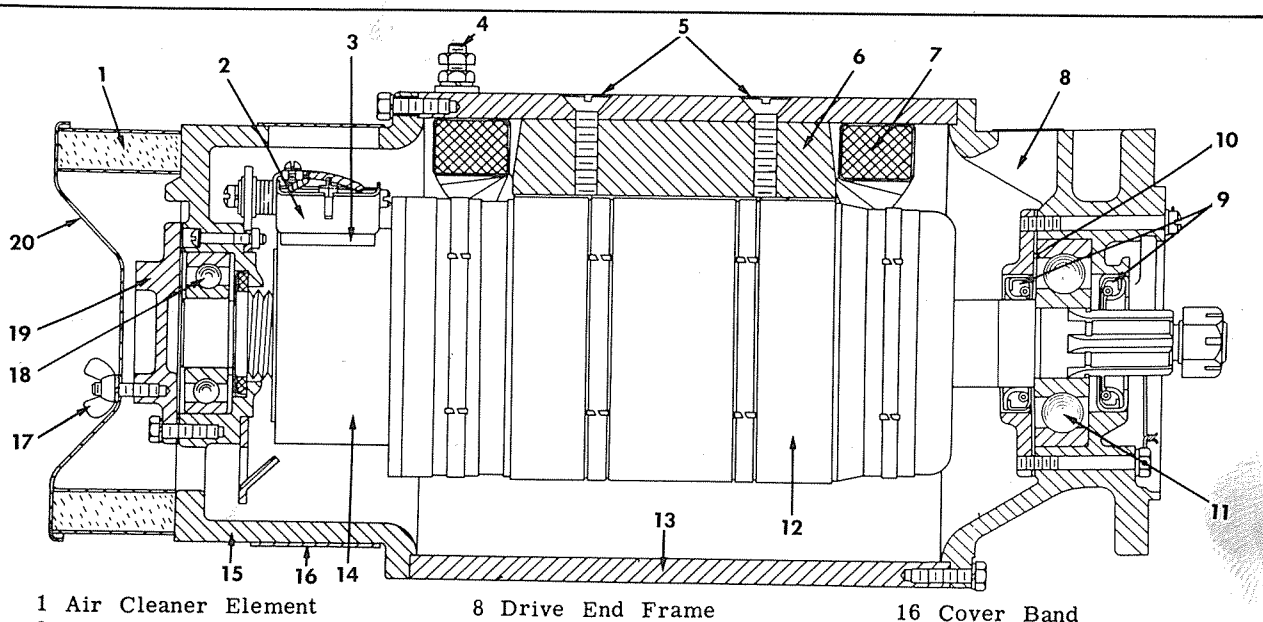
Generator

Contents of This Section

Related Subjects in Other Sections

Generator is a four brush, shunt type with external regulation. Armature shaft is supported by a single row ball bearing at each end. Output of generator is controlled by a generator regulator mounted at right rear corner of vehicle. Regulator service information will be found in Regulator (Sec. 7F of this manual).

Air for cooling and ventilating generator is drawn through unit by engine air intake system (fig. 1). Air entering generator must pass through an oil wetted air cleaner, mounted on commutator end of generator. Air is returned to engine air intake system through tube at drive end of generator. Generator is mounted on flywheel housing and is driven through gears connecting generator and engine balance shaft (fig. 2).



1 Air Cleaner Element
2 Brush Holder
3 Brush
4 Terminal
5 Pole Shoe Screws
6 Pole Shoe
7 Field Coil
8 Drive End Frame
9 Oil Seals
10 Bearing Retainer
11 Drive End Bearing
12 Armature
13 Housing
14 Commutator
15 Commutator End Frame
16 Cover Band
17 Air Cleaner Cover Retaining Nut
18 Commutator End Bearing
19 Commutator Bearing Retainer
20 Air Cleaner Cover

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Figure 1—Sectional View of Generator

GENERATOR

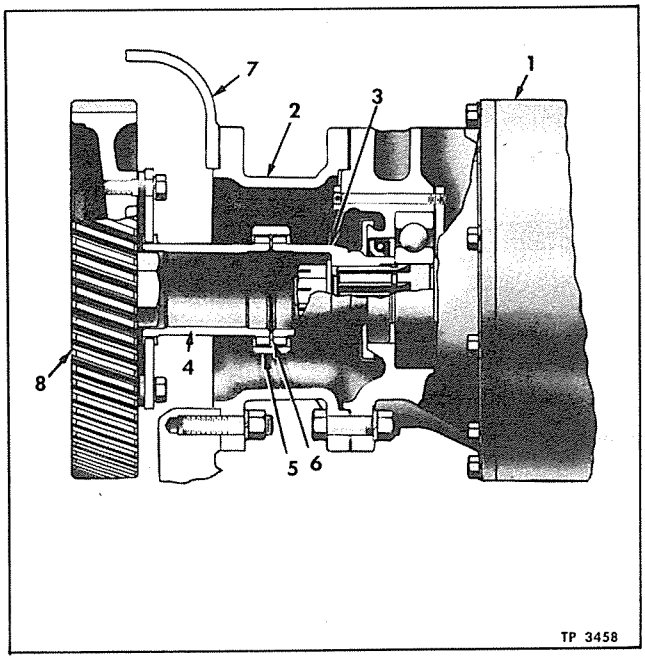


Figure 2—Generator Drive

INSPECTION AND MAINTENANCE

(On Vehicles)

Normal service may be obtained from generator with a minimum of trouble if regular lubrication, inspection, and maintenance procedures are followed.

AIR CLEANER

At regular specified intervals the air cleaner should be removed, cleaned and reinstalled. Refer to Fuel System (Sec. 12A of this manual for procedures. Refer to Lubrication (Sec. 13 of this manual) for interval of application and recommended lubricant.

CLEANING

Exterior as well as the interior of the generator assembly should be kept clean. Use a clean cloth, dampened with cleaning solvent, to wipe off excess grease. Do not steam clean or dip generator into a cleaning solvent. Avoid getting any water or cleaning solution in the generator. If interior of generator is dirty, remove, disassemble and clean all individual parts.

COMMUTATOR

The cover band should be removed and commutator inspected at 5,000 mile intervals. If commutator is dirty, clean with a strip of No. 00 sandpaper.

DO NOT USE EMERY CLOTH. All dust must be blown from generator after commutator has been cleaned.

BRUSHES

Replace worn brushes. Brushes may be seated by use of a "bedding" stone. Do not use emery cloth or sandpaper. With generator operating at medium speed, press bedding stone firmly against commutator to cover area contacted by brushes. Brushes should then seat satisfactorily in a short period. Blow generator out with compressed air to remove all abrasive particles after using stone. Check tightness of pigtail lead connections.

Brush Spring Tension

Check brush spring tension. Replace springs if tension is not as specified in "Specifications" at end of this section.

Excessive spring tension will cause commutator and brushes to wear rapidly; while low spring tension will cause a reduced generator output, also arcing and burning of commutator and brushes.

MISCELLANEOUS

Make careful inspection of wires, terminals and all visible parts of generator. Any apparent defects should be corrected immediately. A poor connection in charging circuit will cause generator to build up excessive voltage which may result in burned field or armature windings. A poor connection in generator field circuit will cause a low output.

Noise in generator may be caused by loose mounting or worn drive parts. Worn or dirty bearings which may cause noise, require cleaning and lubrication or, if worn excessively, replacement. Improperly seating brushes or bent brush holder may cause noise, requiring replacement.

GENERATOR DRIVE

Flange of generator drive end frame is bolted to an adapter, which is in turn bolted directly to flywheel housing. External teeth on generator drive hub and external teeth on drive coupling mesh with internal teeth of drive coupling ring to provide direct drive from engine balance shaft to generator, as shown in figure 2.

REPLACEMENT

REMOVAL

1. Remove bolts attaching air outlet hose fitting to generator.
2. Remove stud nuts and lock washers from three terminals on generator, then remove wires from each terminal. Tag each wire for identification at time of reinstallation.
3. Remove bolts, nuts, and lock washers attaching generator to generator adapter. Carefully pull generator straight away from engine to complete removal.

INSTALLATION

1. Position generator on adapter, making sure generator drive hub teeth mesh with coupling teeth. Install bolts, lock washers, and nuts. Tighten nuts evenly and alternately until tight.

2. Install wires on three generator terminals according to identification used at time of removal or refer to Wiring (Sec. 7A of this manual). Install lock washers and nuts and tighten securely.

3. Position air outlet fitting on generator drive end flame, install attaching bolts and lock washers, then tighten bolts securely.

4. Before starting engine, polarize generator.

POLARITY

When generator or regulator wires have been disconnected, especially when new unit is being installed, generator must be polarized after units are installed - BEFORE ENGINE IS STARTED. Failure to polarize generator will cause regulator points to vibrate excessively and burn. Remove wire from "F" terminal at generator. Use jumper wire to momentarily connect "F" terminal on generator and "Ammeter" terminal on regulator. This connection allows a momentary surge of battery current to reach generator fields, which automatically gives generator the correct polarity with respect to battery it is to charge. Reconnect wire to generator "F" terminal.

TESTING

Before generator is removed from engine, or with generator on bench, Operation Tests in the Regulator (Sec. 7F of this manual) should definitely establish which unit, generator or regulator is at fault. When it has been definitely established that generator is at fault, localize trouble in generator as follows:

1. NO OUTPUT

Remove cover band and check for sticking brushes, or for other causes of poor contact between commutator and brushes. Correct sticking brushes by cleaning brush holders and brush arms. Correct dirty armature as explained under "Inspection" later in this section. If trouble is still not corrected, test further as below:

a. Test for grounded armature by raising and insulating the grounded brushes from the commutator and checking with test points from "ARM" terminal to frame. If test lamp lights, raise other brushes and check "A" terminal and commutator separately.

b. Test for open field circuit with test points between "F" terminal and "G" terminal. If test lamp fails to light, field is open circuited. Replace field if defective.

c. Test for shorted field circuit with battery and ammeter connected in series with field circuit. A shorted field will draw excessive current, so care must be taken to avoid damaging ammeter. Refer to "Specifications" later in this section for current draw. If shorted field is found, replace.

d. An open circuit in the armature is usually readily apparent, as this condition usually causes burned armature bars.

e. If trouble has not yet been located, remove the armature and check on a growler for short circuit in manner described under "Testing Parts" later in this section.

2. EXCESS OUTPUT

Generator will produce excessive output due to an internal short that prevents generator regulator from inserting resistance into field circuit. This condition however, is very rare since the short would have to be between the insulated brush and "FLD" terminal of the field circuit to produce this result.

3. UNSTEADY OR LOW OUTPUT

Unsteady or low generator output may result from several conditions as follows:

a. Sticking brushes, low brush spring tension, dirty commutator or other conditions which prevent good contact between brushes and commutator. Correct as directed under "Inspection and Maintenance" previously in this section.

b. Rough, out-of-round, burned commutator, or if dirty between segment slots, or has high mica, may cause low or unsteady output.

DISASSEMBLY

1, Remove three wing nuts, then lift air cleaner cover and element from commutator end head. Loosen screw to remove cover band.

2. Remove screws and lock washers attaching commutator end head to field frame. If necessary, tap end frame with soft hammer to loosen, then remove end head assembly.

3. Remove cap screws and lock washers attaching bearing retainer to commutator end head. Remove retainer and gasket. Remove screws and lock washers attaching brush plate assembly to commutator end head. Remove brush plate assembly. Remove bearing assembly and felt seal washer from commutator end head.

4. Note position of grounded and insulated brushes also location of insulating washers so that they can be reassembled to their original position.

5. Remove cap screws and lock washers attaching drive head to field frame. If necessary, tap end head with soft hammer to loosen, then remove end head and armature.

6. Remove nut and washer on drive end of

GENERATOR

armature shaft. Press armature out of drive end head, remove drive gear from armature.

7. Remove bolts and lock washers attaching bearing retainer to end head. Remove retainer with seal and gasket. Remove bearing from drive end head.

8. Field coils and pole shoes may be removed from the field frame by removing pole shoe screws and disconnecting field coil lead or removing stud. NOTE: Field coil test must be made before the field coils are removed from the generator.

INSPECTION

CLEANING

All parts except field coils and armature should be washed in cleaning solvent. Field coils and armature should be wiped clean with a dry rag.

ARMATURE

Check armature to commutator leads to be sure they are properly soldered. Loose leads should be resoldered as directed under "Repair" later in this section.

COMMUTATOR

Inspect commutator and if found to be rough, out-of-round, worn or has high mica, filled slots or is burned it must be replaced or repaired as directed under "Repair" later in this section.

FIELD COILS

Use care in handling the coil assembly to avoid breaking or weakening leads. The field insulation must be in good condition. If insulation is cracked, charred or worn so that wire is exposed, repair as directed under "Repair" later in this section or replace.

BRUSHES

Replace brushes if worn down to less than half their original length. Be sure that pigtail leads are secure in the brushes, and that clips are properly soldered to the leads.

Brush Springs

Brush springs must have sufficient tension to provide proper pressure between brushes and commutator after the generator is reassembled. Replace springs if damaged or if tension is not as shown in "Specifications" later in this section.

Brush Holders

Carefully examine brush arms, arm pins, and holders for bent, warped or damaged condition. Any condition that might interfere with proper brush action should be corrected.

BEARINGS

Carefully inspect ball bearing for evidence of damage, and wear. Replace if worn or damaged. Install end frame assembly on armature shaft to check clearance between bushing and shaft. If clearance is excessive replace bushing as directed under "Repair" later in this section.

SEALS

Felt Type

Carefully inspect felt seal for damage or excessive wear. If seal is worn or damaged it must be replaced as directed under "Repair" later in this section.

Lip Type

Inspect seals for wear, deterioration or damage to the sealing surface. Replace as directed under "Repair" later in this section if any damage is evident.

MISCELLANEOUS

Carefully inspect insulators and insulating washers for damage or burned condition. Inspect all studs or screws for bent or damaged condition and cross threads.

TESTING PARTS

Generator parts may be tested with suitable electrical testing equipment. Illustrations showing application of test equipment are merely typical. Instructions furnished by manufacturer of test instrument used, should be followed.

ARMATURE

Following armature tests should always be made while generator is disassembled.

Ground

With a conventional test light and prods, place one test prod on armature and other to commutator (fig. 3). If test light lights, armature is grounded and should be replaced.

Open Circuited

An open circuit in the armature usually results in badly burned commutator bars which can be easily detected visually.

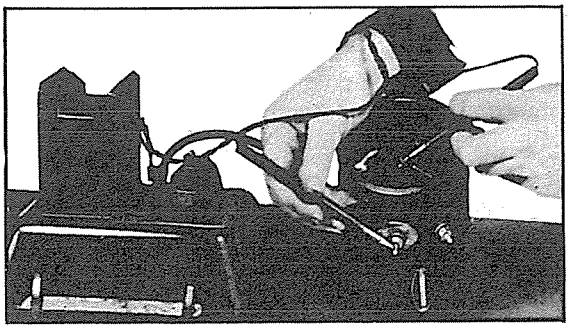
Short Circuited

Place armature on growler connected to alternating current. Hold hack saw blade over armature while armature is rotated slowly (fig. 3). If saw blade vibrates or buzzes, armature is short circuited. Before replacing an armature that is apparently shorted, inspect the commutator slots for copper or brush dust deposits. Clean thoroughly and again test.

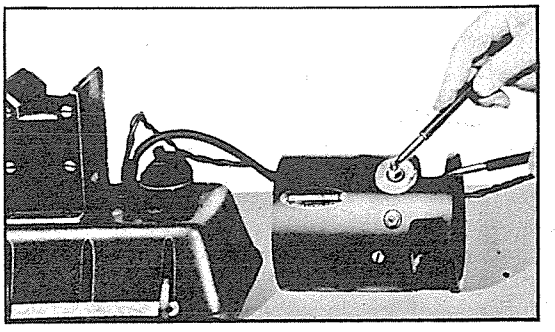
TERMINAL CIRCUIT TEST

Place one test prod on armature terminal and other on terminal of each wire (fig. 3). If test lamp does not light, wire is open circuited and should be replaced.

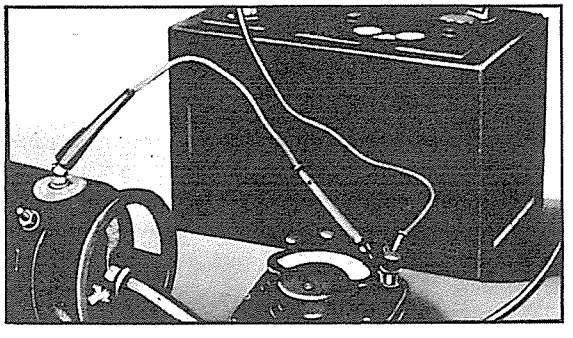
GENERATOR



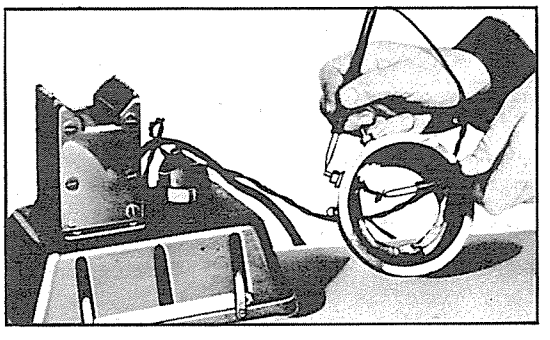
FIELD COIL TEST FOR CONTINUOUS CIRCUIT



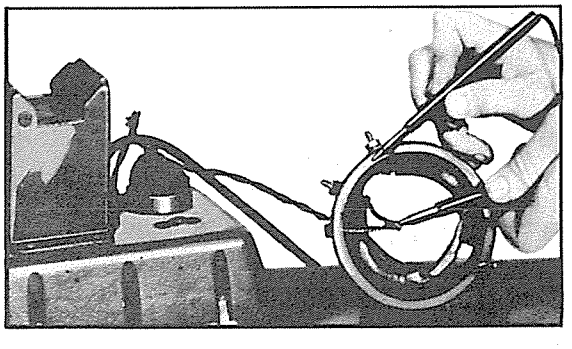
FIELD COIL TEST FOR GROUND



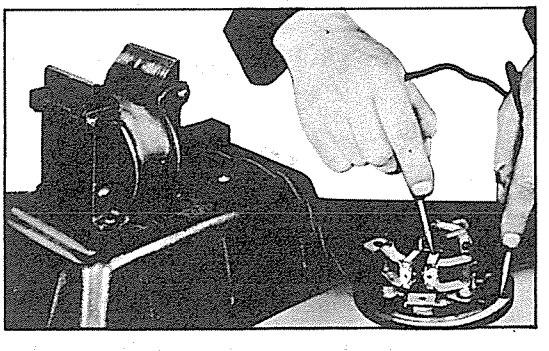
FIELD COIL BALANCING TEST



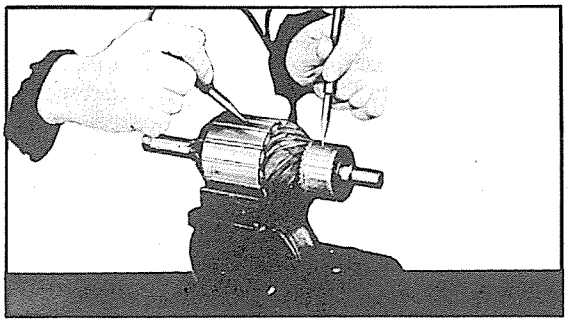
TERMINAL TEST FOR CONTINUOUS CIRCUIT



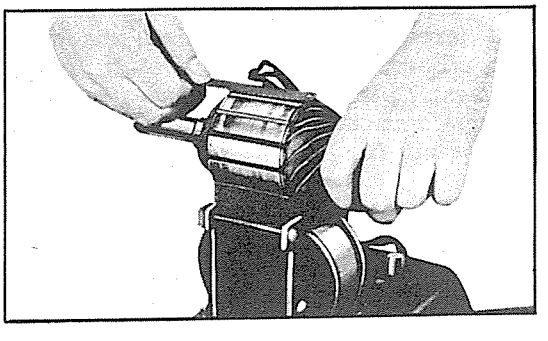
TERMINAL TEST FOR GROUND



INSULATED BRUSH HOLDER TEST



ARMATURE TEST FOR GROUND



ARMATURE TEST FOR SHORT

Figure 3—Generator Tests

GENERATOR

FIELD COILS

Following field coil tests should be made while coils are installed in place in housing.

Continuous Circuit

Remove grounded end of field coil from inside of field frame. Place test prods on field coil terminals as illustrated in figure 3. If test lamp does not light, field coils are open circuited and should be replaced.

Ground

Disconnect grounded end of field coil winding from housing. Place one test prod on generator housing and other on field terminal (fig. 3). If test lamp lights, field coils are grounded and should be replaced.

Current Draw Test

Remove grounded end of field coil from inside of field frame. Place test lead on ground terminal and other test lead on "F" terminal, with ammeter connected (fig. 3). Take ammeter reading. Remove test leads and securely reconnect ground lead to inside of field frame. Field coils should draw current as indicated in "Specifications" later in this section. Replace if they do not meet "Specifications."

BRUSH HOLDER TEST

Place one test prod on insulated brush holder and other on end frame. (fig. 3). If test lamp lights, brush holder is grounded and should be replaced.

REPAIR

COMMUTATOR

Turning Down. Place armature in lathe then turn down to remove worn spots, out-of-round, rough or worn condition. Do not cut-off more than necessary. If end of commutator segments are less than 1/16" wide the armature must be replaced.

Undercut Mica. Mica between segments must be below the edge of segment. Start groove with a small three-cornered file, then use hack-saw blade to undercut the mica until it is 1/32" below segment. Use No. 00 sandpaper to clean and smooth up commutator, then use compressed air to remove all fine particles of cuttings.

ARMATURE

Welding Leads. When commutator riser bars are burned this is often caused by an open-circuited armature due to excessive output. When the bars are not too badly burned, the armature can sometimes be saved by rewelding the leads in the riser bars. After welding turn down the commutator and under-cut the mica until it is 1/32" below segments.

FIELD COILS

Insulation. If the insulation is worn so that the field wiring could become grounded coil can sometimes be repaired by rewrapping the field coils. Rewrapping must be done with extreme care and neatness, as excessive wrapping may hinder reassembling.

Connections. If connections between coils are loose, resolder. Always use rosin flux when resoldering electrical connections - NEVER USE ACID FLUX;

SEALS

Felt Type. Remove felt seal and retainer using punch to drive out retainer. Use file or stone to remove any metal staked over at time of installation.

Install felt seal in retainer, then press retainer, and seal in place. Press retainer until it is seated or is flush with part into which it is being installed. Use prick punch to stake retainer in place.

Lip Type. Use drift or punch to drive lip type seals from drive end head.

Install new seal assemblies with lips of seals toward bearing. Position seals on end head and press in to place with suitable replacing tool or drive seals into place with block of hard wood and hammer. Seals are properly positioned when edge of seals are flush with end head.

REASSEMBLY

1. Install field coils and pole shoes in field frame (housing) and attach with pole shoe screws. Install "F" terminal in field frame, being sure it is properly insulated from field frame. Attach field coil ground wire to the field frame. If the field coil leads have been separated, they should be soldered and insulated.

2. Install bearing in drive end head. Position bearing retainer and seal assembly against inside of drive end head, using gasket between the two parts. Secure retainer to end head with cap screws and lock washers. Thread soft wire through drilled head of screws to prevent loosening.

3. Apply small quantity of engine oil to leather seals and contacting surface of armature shaft. Install armature shaft through drive end head, being sure that seals are not damaged. Install drive gear and secure with new self locking nut. IMPORTANT: Use torque wrench and tighten gear nut to 180 ft. lbs.

4. Position field frame over armature with drive end head properly located against field frame. Install cap screws and lock washers then tighten alternately and evenly.

5. If commutator end head has been disassembled it should be reassembled at this time. Be sure that brushes, brush holders and insulating washers are assembled in their proper position as noted at time of disassembly.

6. Install bearing in commutator end head. Position bearing retainer to commutator end head, using gasket between these two parts. Secure retainer to commutator end head with cap screws and lock washers.

7. Apply small quantity of engine oil to felt seal and contacting surface of armature shaft. Install armature shaft into commutator end head bearing, being sure that felt seal is not damaged. Install cap screws and lock washers then tighten alternately and evenly.

8. Install cover band. Install air cleaner element and air intake cover.

9. Before installing generator, check as described under "Testing" earlier in this section.

SPECIFICATIONS

Make	Delco Remy
Model	1117566
Rotation (Viewed at Drive End)	Counterclockwise
Brush Spring Tension (Oz)	25
Field Current @ 12 Volts (Amps)	1.78 - 1.92

COLD OUTPUT

Amperes	120
Volts	13
R.P.M. (Approx.)	850

HOT OUTPUT

Maximum Output Controlled by Current Regulator

GENERATOR

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference - Make note of bulletin number in space below:

NOTES

Regulator

Contents of This Section

Related Subjects in Other Sections

The generator regulator, used on these vehicles as standard equipment, is five unit type, consisting of voltage regulator, field relay, current regulator, cutout solenoid and actuating relay (fig. 1). Unit is mounted on an engine compartment panel at right rear corner of vehicle. Regulator is accessible, through a door at corner of vehicle.

Regulator controls generator output, varying output to meet demands of the electrical system and battery. Output of generator is not increased by regulator - regulator serves only to reduce generator output when full output is not required by electrical system.

Wiring diagram of generator and regulator units is shown in figure 2.

OPERATION

Field Relay

The field relay is a unit to control field current. The field current is carried through field relay contacts, and relay is operated by voltage regulator, which is connected directly across generator.

Voltage Regulator

The voltage regulator increases, or decreases generator output in accordance with battery requirements and the connected electrical load.

Current Regulator

The current regulator limits the generator output to a specified value, which is governed by the setting of the regulator.

Actuating Relay

The actuating relay is connected across generator so that when sufficient voltage is generated to charge battery the relay points close and energize the cut-out solenoid. When the generator voltage falls below a value sufficient to charge the battery the actuating relay points open to break circuit between generator and battery.

Cut-Out Solenoid

When cut-out solenoid is energized by actuating relay, as described above, multiple contact points are closed to complete the circuit between generator and battery. As generator voltage falls below a value sufficient to charge battery, the contact points are opened by action of actuating relay, thus circuit between generator and battery is broken.

INSPECTION ON VEHICLES

In general, avoid tampering with a regulator that is functioning properly. However, periodic inspection can add greatly to the life of the regulator by disclosing conditions which if not cor-

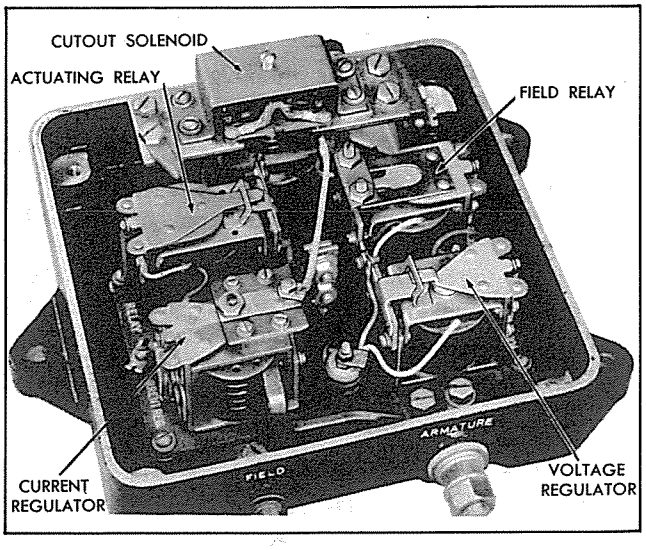


Figure 1—General View of Regulator

REGULATOR

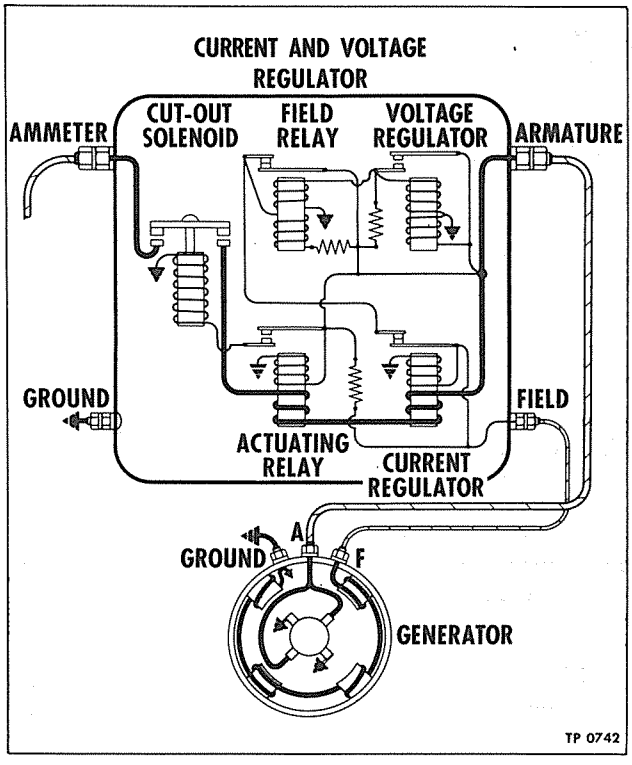


Figure 2—Generator and Regulator Wiring Diagram

rected, would result in damage to regulator, generator, or other units of the electrical system.

Regulator cover should be removed and visual inspection made for dust or corrosion of units, and with engine running, condition and action of points. Terminal mounting, and cover screws should be tightened. This inspection coupled with a check of battery and generator will afford a good indication of correct generating system operation.

COVER INSPECTION

Regulator may become inoperative in service due to dust or moisture collecting inside unit; improper sealing of gasket between cover and regulator base being the major contributing factor. Examine gasket carefully for defect - evidence of poor sealing can usually be found on gasket. Replace gasket if found defective.

Inspect cover and make certain it is not distorted or damaged. Install cover and attaching screws, tightening screws firmly and with equal tension. Press on each end of cover after tightening screws. If cover can be moved, it is evidence of a poor seal.

TERMINALS

Regulator terminals must be kept tight and clean to insure proper functioning of regulator. Remove all traces of corrosion from both wire and regulator terminals. Replace any wiring that shows evidence of swollen or worn insulation. CAUTION: If wires are disconnected, polarize generator as directed in "Polarity," before starting engine.

POLARITY

Whenever generator or regulator are tested or replaced or when wires have been disconnected, generator must be polarized to insure correct polarity with respect to electrical system. GENERATOR MUST BE POLARIZED BEFORE ENGINE IS STARTED. Remove wire from "F" terminal at generator. Use jumper wire to momentarily correct "F" terminal on generator and "Ammeter" terminal on regulator. This allows a momentary surge of battery current to flow to generator field windings, which automatically gives generator correct polarity with battery it is to charge. Failure to do this will cause the cut-out solenoid and actuating relay contacts to vibrate and burn so that they will be seriously damaged.

ARCING AND ACTION OF POINTS

Excessive arcing or sluggish action of contact points in either current or voltage regulator units is an indication of one of the following:

1. Resistance unit is open.
2. Defective winding in regulator.
3. Contact points pitted or oxidized.
4. Contact points incorrectly aligned, or meeting with improper pressure.
5. Shorted field coil in generator.
6. Poor ground connection between generator and regulator.

Cleaning Contact Points

Regulator contact points should be inspected for evidence of dirt, oxidation, and pitting or burning, and cleaned whenever necessary. Dirty or oxidized points arc and burn, causing reduced generator output and run-down battery.

Contact points are removable and may be cleaned with a flat file. Do not use a file that is oily or greasy, and avoid filing away more material than is necessary to remove pits from points. NEVER USE SANDPAPER OR EMERY CLOTH TO CLEAN CONTACT POINTS.

OPERATION TESTS

Tell-tale light on instrument panel merely indicates whether or not generating system is functioning. However, in combination with a battery test, tell-tale light serves to indicate possible malfunctioning of battery, generator or regulator.

Operating Temperature

Before any attempt is made to check regulator current and voltage settings, it is important that unit be at operating temperature (135° to 145°). Operate unit for at least 30 minutes to obtain operating temperature.

Fully Charged Battery and Low Charging Rate

Above condition indicates that generator and regulator are functioning properly. Verify this by noting charging rate at medium generator speed. Then crank engine with starting motor for about 10 seconds to partly discharge battery. Run generator again at medium speed and note charging rate. Since battery voltage has been lowered, generator output should show an increase for a short period.

Check current regulator unit by bridging field relay points (fig. 16). Turn on all lights or other electrical loads and increase generator speed until output remains constant. The output reading is the value for which current regulator is set. Refer to "Specifications" later in this section for correct setting.

If output fails to increase to specified value, current regulator setting is probably low. Adjust current regulator as specified under "Current Regulator Current Setting" later in this section. If it is impossible to adjust regulator to specified output, check conditions as outlined under "Low Battery and Low or No Charging Rate" later in this section.

Fully Charged Battery and High Charging Rate

Above condition indicates that voltage regulator unit is not reducing generator output as it should. A high charging rate to a fully charged battery will cause battery to gas and overheat. It also produces excessive voltage in electrical circuit which is very injurious to all electrical units.

A fully charged battery and high charging rate can be caused by one of the following conditions:

1. Voltage regulator out of adjustment.
2. Defective winding in voltage regulator unit which prevents unit operating.
3. Direct short between charging circuit and field circuit, either in regulator or generator, which prevents resistance being inserted into field circuit when contact points open.
4. Poor ground connection between generator and regulator.
5. High temperature which reduces the resistance of the battery to charge so that battery will accept a high charging rate, even though the voltage regulator setting is normal.
6. If the cause of the trouble cannot be considered due to temperature, proceed as follows to locate trouble.

a. Remove lead from regulator "Field" terminal while generator is operating at medium speed.

b. If the output remains high, the generator or wiring is at fault. Reconnect wire to regulator. Remove wire from "F" terminal of generator to determine if fault is with generator or wiring. If output drops off, the wiring is at fault or if output remains high, the generator is at fault.

c. If output drops off with lead removed from regulator "Field" terminal (a. above) the regulator is at fault and should be inspected for burned leads, windings or insulation.

Low Battery and High Charging Rate

This is an indication of normal generator regulator operation. However this condition should not be prolonged as the high charging rate should soon charge the battery and therefore return to a low charging rate and fully charged battery. Failure of battery charge to be restored indicates that regulator is improperly adjusted or that battery is faulty.

Low Battery and Low or No Charging Rate

Check circuit for loose connections, frayed or damaged wires, low regulator setting or oxidized contact points, if above condition exists. High resistance in charging circuit, due to these conditions, will cause voltage regulator to operate as though battery were fully charged, reducing generator output, even though battery is in a partly discharged condition. If trouble is not in wiring, make following checks.

Bridge regulator terminals marked "ARMATURE" and "FIELD" temporarily with a jumper lead while generator is operating at medium speed. Bridging terminals removes all external regulation and may allow generator output to reach an excessive value. With terminals bridged, one of the two following actions will result. Generator output will increase to or above or will not increase to its specified value. Check each condition in the following manner.

1. If generator output increases to or above its specified value this indicates one of the following conditions:

a. Voltage or current regulator is adjusted for too low a value.

b. Oxidized regulator contact points which insert excessive resistance in generator field circuit.

c. Generator field circuit open within the regulator, either at the connections or in the regulator windings.

2. If generator output does not increase to its specified value this indicates that generator or actuating relay or cut-out solenoid is at fault,

REGULATOR

a. If actuating relay points are closed and there is no charging current this indicates that circuit is open between regulator and battery.

b. If contact points are open connect a voltmeter between "ARMATURE" terminal on regulator and convenient ground on generator to check voltage build-up. If voltage is satisfactory without causing actuating relay or cut-out solenoid to close it indicates that these units are out of adjustment or unit windings are open. CAUTION: Do not close relay points manually while battery is connected.

MECHANICAL ADJUSTMENTS

(Air Gap And Point Opening)

Air gap and point opening must be set before attempting to adjust current and voltage settings. REGULATOR MUST BE DISCONNECTED DURING THESE ADJUSTMENTS.

Adjustment of regulator air gap and point opening can be made at bench if regulator has been removed; however, final electrical adjustments should be made, with unit installed in its proper position in vehicle. The regulator must be disconnected from battery before any mechanical adjustments (air gap and point opening) are made.

Field Relay Air Gap Adjustment

1. Measure air gap between brass residual pin in armature and magnetic core (fig. 3). This dimension should be as listed under "Specifications" later in this section.

2. If air gap requires adjustment, loosen two lock nuts and turn contact screws until proper adjustment is obtained (fig. 3). Tighten lock nuts when adjustment has been completed.

3. If the proper air gap cannot be obtained by adjustment of the two contact screws, loosen the two screws that attach the upper contact bracket to the frame and raise or lower the bracket as required.

4. Point opening of each set of points must be identical so that each point carries half the current. A final check must always be made after the regulator is installed and in operation. If more arcing takes place at one set of points than other it indicates that it is carrying more current than other and must be readjusted so that they are equal.

Voltage Regulator Air Gap Adjustment

1. Press armature down until contact points touch, then measure air gap between armature and brass residual pin in core (fig. 4). This dimension should be as listed under "specifications" later in this section.

2. If air gap requires adjustment, loosen two adjusting screws (fig. 4) holding lower contact bracket. Adjust bracket up or down until gap is as specified under "Specifications" later in this section. Be sure screws are tightened well after adjustment.

Voltage Regulator Point Opening Adjustment

1. Check point opening as shown in figure 5. Opening should be same as listed under "Specifications" later in this section.

2. To adjust, bend armature stop (fig. 5) until proper point opening is obtained.

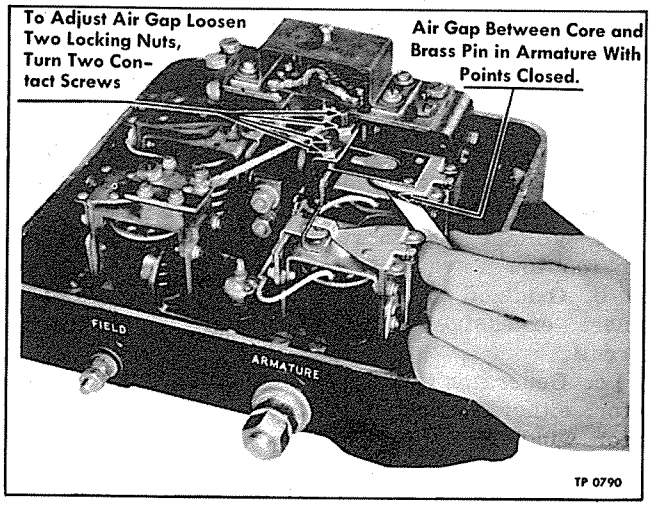


Figure 3—Field Relay Air Gap Check and Adjustment

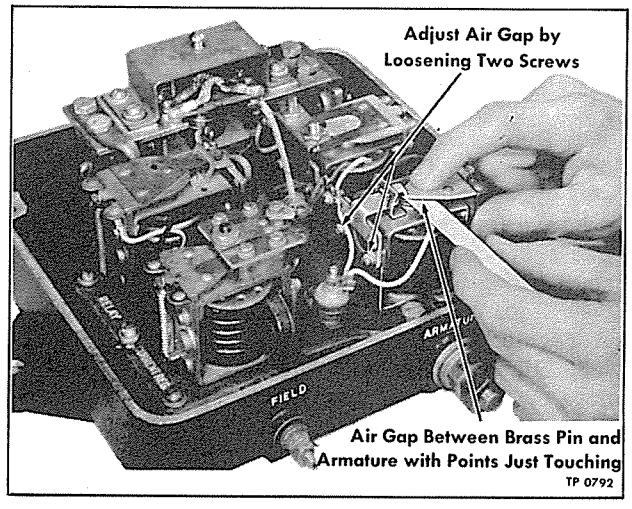


Figure 4—Voltage Regulator Air Gap Check and Adjustment

REGULATOR

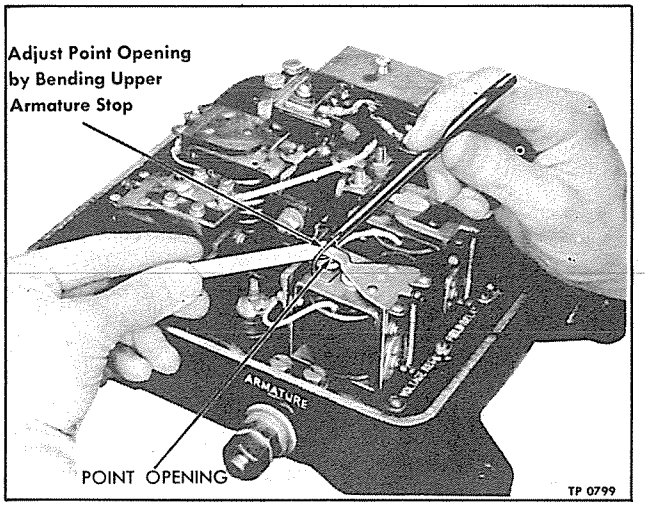


Figure 5—Voltage Regulator Point Opening Check and Adjustment

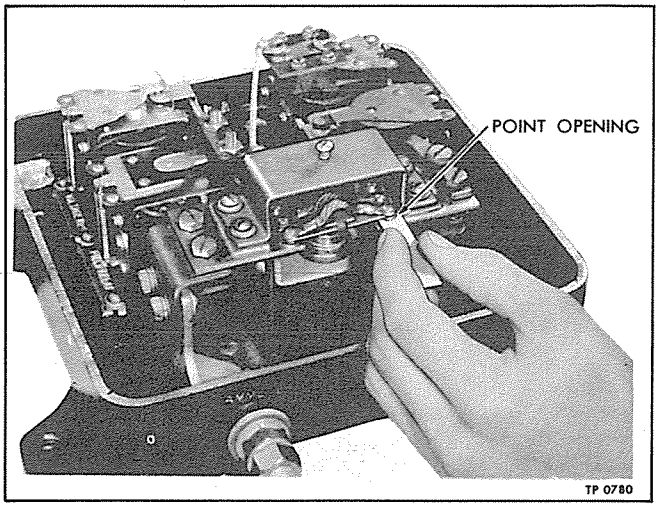


Figure 6—Cut-out Solenoid Point Opening Check

Cut-Out Solenoid Point Opening

1. Measure point opening gap with feeler gauge (fig. 6). This dimension should be as listed under "Specifications" later in this section.

2. If point opening requires adjustment, loosen adjusting screw lock nut and turn adjusting screw in or out as necessary until proper point opening is obtained (fig. 7). Tighten lock nut when adjustment has been completed.

3. Point opening of each set of points must be identical so that points carry equal current.

4. Check guide pin for straightness so that it does not bind and prevent free plunger travel.

Actuating Relay Air Gap Adjustment

1. Press armature down UNTIL POINTS JUST MEET and measure air gap between core and brass residual pin on armature (fig. 8). This dimension should be as listed under "Specifications" later in this section.

2. Adjust bracket up or down until gap is as specified under "Specifications" later in this section. Be sure screws are tightened after adjustment.

Actuating Relay Point Opening

1. Check point opening using feeler gauge (fig. 9). Opening should be same as listed under "Specifications" later in this section.

2. To adjust, bend armature stop (fig. 9) until proper point opening is obtained.

Current Regulator Point Opening

1. Check point opening with armature held down against core (fig. 10). Opening should be same as listed under "Specifications" later in this section.

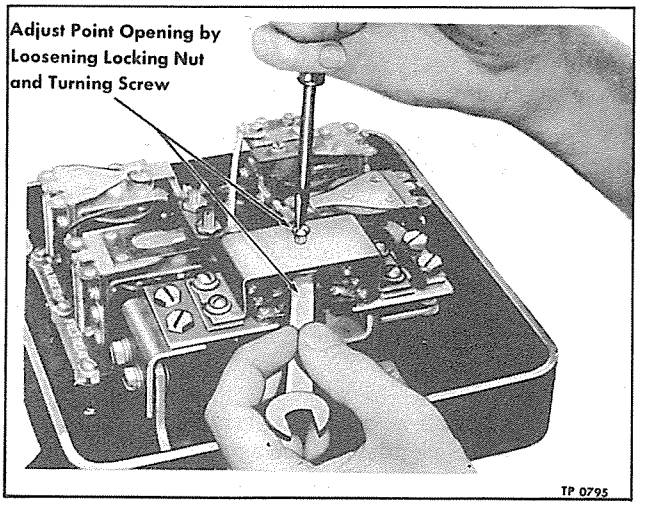


Figure 7—Cut-out Solenoid Point Opening Adjustment

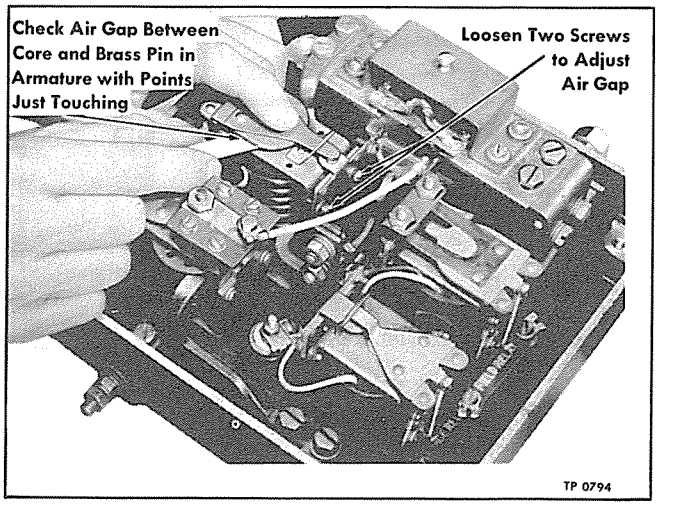


Figure 8—Actuating Relay Air Gap Check and Adjustment

REGULATOR

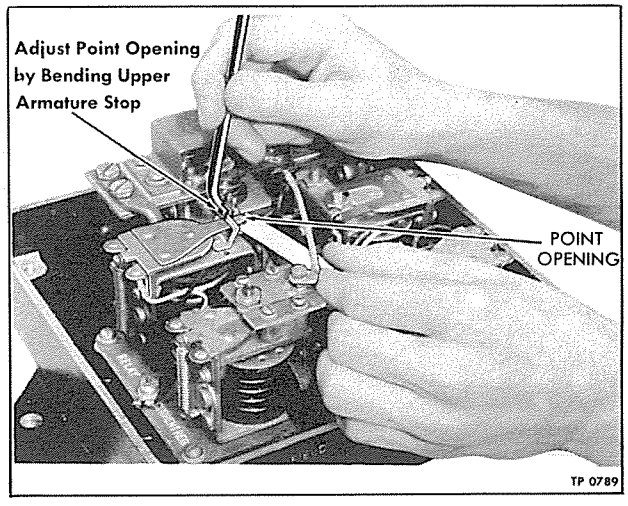


Figure 9—Actuating Relay Point Opening Check and Adjustment

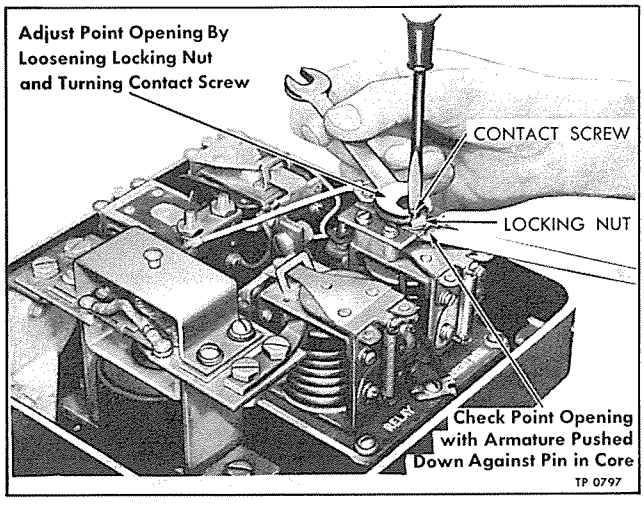


Figure 10—Current Regulator Point Opening Check and Adjustment

2. To adjust, loosen lock nut and turn contact screw (fig. 10) until gap specified under "Specifications" later in this section has been obtained. Tighten lock nut when point opening is correct. Press down armature and again check point opening.

ELECTRICAL ADJUSTMENTS

(Current And Voltage)

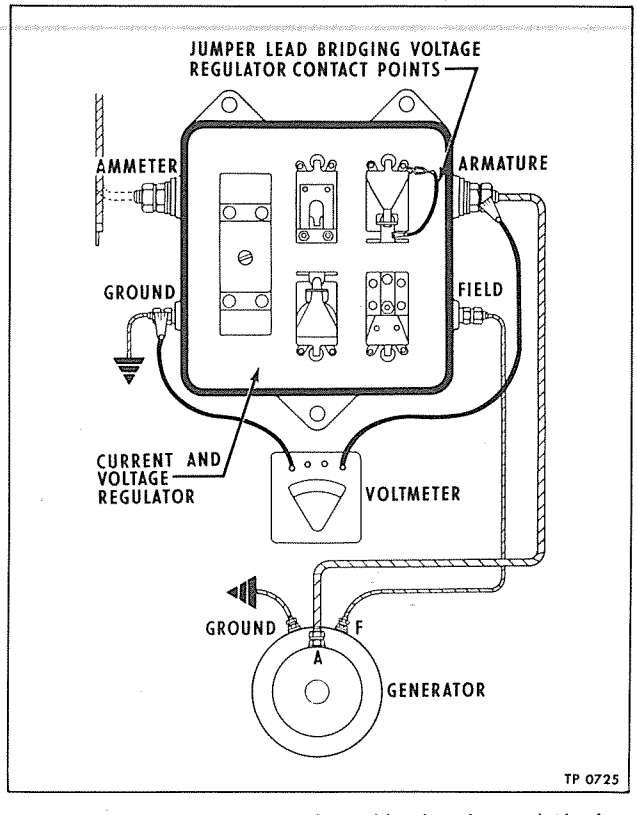


Figure 11—Meter Connection for Field Relay Electrical Check

When making current and voltage adjustments, obviously the regulator must be connected to generator and battery of proper voltage and with correct terminal grounded as specified on regulator model plate.

Air gap and point opening adjustments must have been completed as described under "Mechanical Adjustments" previously in this section.

CAUTION: Never close actuating relay or cut-out solenoid points by hand while regulator is connected to the battery. This would allow sufficient current to flow from the battery to cause serious damage to the regulator units.

Operating Temperature. Before any attempt is made to check regulator current and voltage settings it is important that unit be at operating temperature (135° to 145°). Operate unit for at least 30 minutes to obtain operating temperature.

Sequence of electrical adjustment (current and voltage checks) must be made in the following order.

1. Field relay operating voltage.
2. Voltage regulator voltage setting.
3. Cut-out solenoid operating voltage.
4. Actuating relay operating voltage.
5. Current regulator current setting.

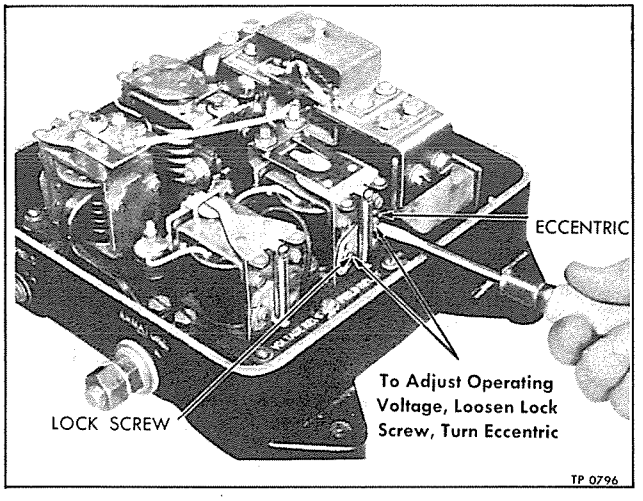


Figure 12—Field Relay Operating Voltage Adjustment

Field Relay Operating Voltage

1. Connect a jumper lead between voltage regulator points (fig. 11) to prevent regulator operation.

2. Disconnect battery lead at regulator "Ammeter" terminal. Connect a test voltmeter between regulator "Armature" terminal and "ground" (fig. 11).

3. Run generator at about 1275 R.P.M. and note operating voltage. Refer to "Specifications" later in this section for correct voltage.

4. To adjust, loosen lock screw and turn eccentric screw to change spring tension (fig. 12). Increasing tension increases voltage setting, decreasing tension lowers voltage setting.

5. Tighten lock screw and check setting by stopping generator and then bring it back to speed, to again check voltage setting. Remove jumper lead when setting has been completed.

Voltage Regulator Voltage Setting

1. Connect a test voltmeter between "armature" terminal and "ground" screw, and disconnect lead from "ammeter" terminal (fig. 13).

2. Run generator at approximately 1275 R.P.M. and note voltage setting. Refer to "Specifications" later in this section.

3. To adjust, loosen lock screw and turn eccentric screw to change spiral spring tension. Increasing tension increases voltage setting, decreasing tension lowers voltage setting.

4. Tighten lock screw and check setting by reducing generator speed until actuating relay points open, then bringing generator back to speed.

Voltage setting of 15 volts as given in specifications is maximum to which regulator should be set. Under certain operating conditions regulator may be set below 15 volts and still keep batteries charged. Frequent need for water in battery is an indication of excessive charging and

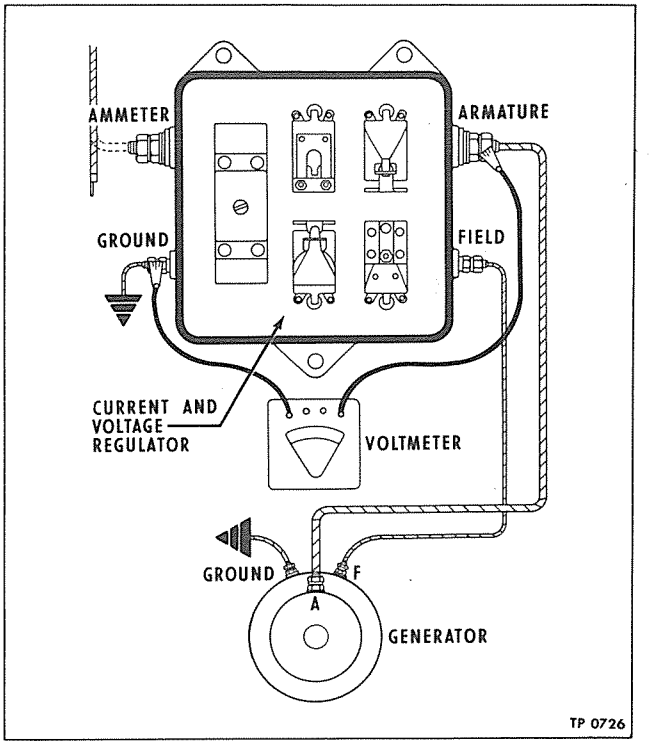


Figure 13—Meter Connections for Voltage Regulator Voltage Setting Check

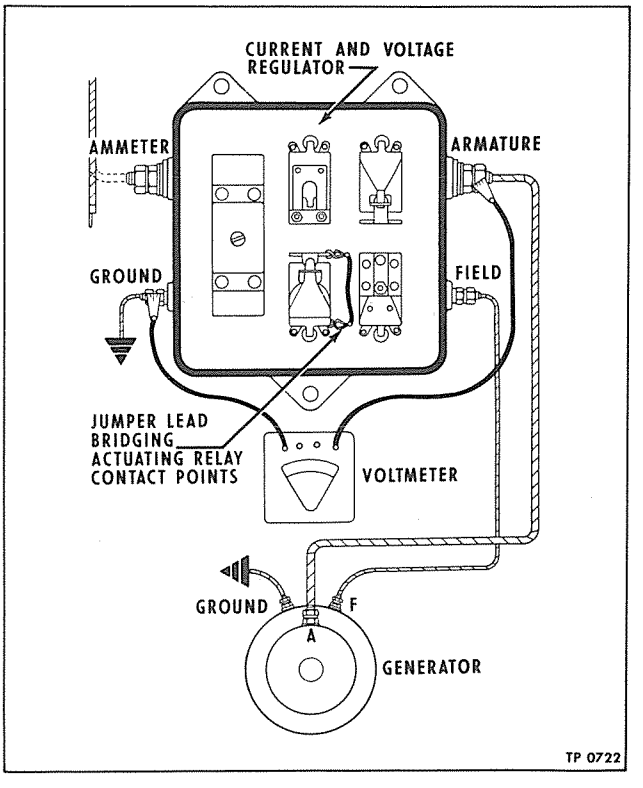


Figure 14—Meter Connections for Cut-out Solenoid Operating Voltage

REGULATOR

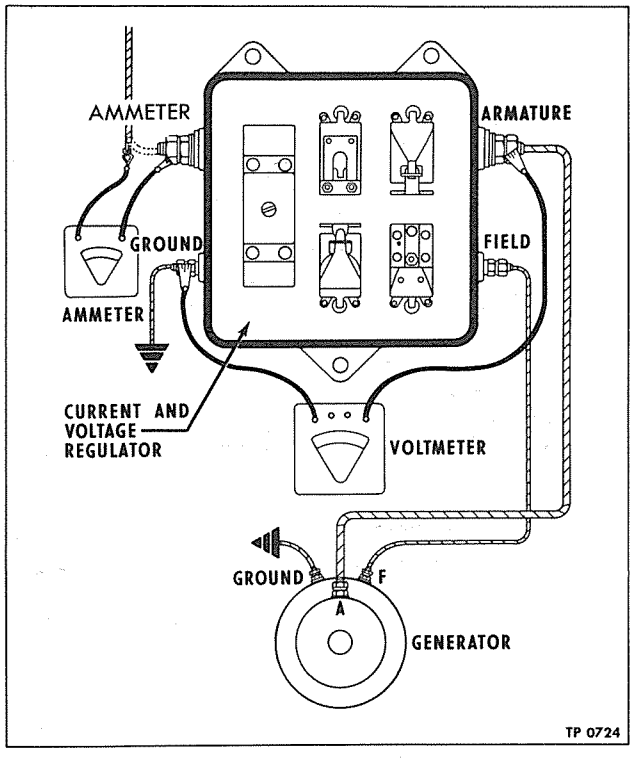


Figure 15—Meter Connections for Actuating Relay Closing Voltage Check

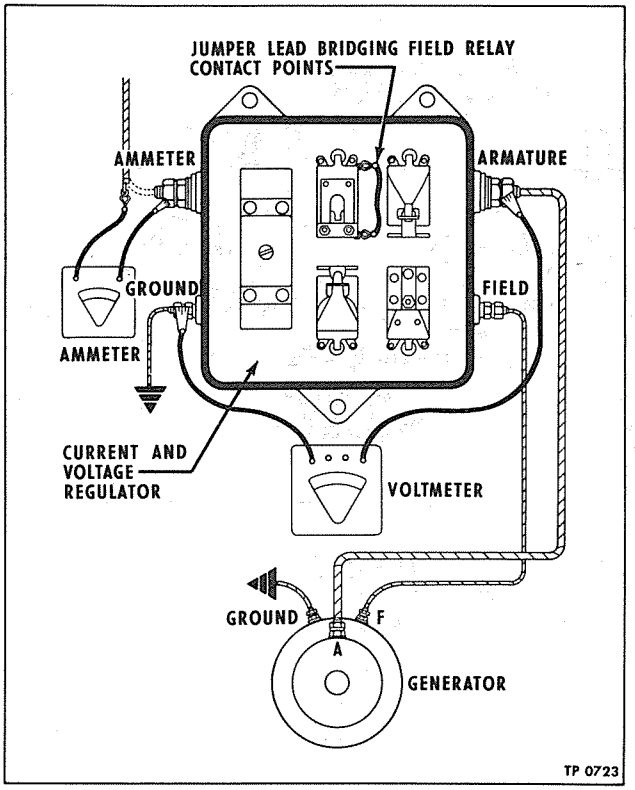


Figure 16—Meter Connections for Current Regulator Current Setting Check

reduction in regulator setting will prevent this.

CAUTION: NEVER SET VOLTAGE REGULATOR SETTING BELOW ACTUATING RELAY VOLTAGE SETTING. TO DO SO WILL PREVENT CUT-OUT SOLENOID FROM OPERATING AND WILL PREVENT BATTERIES FROM BEING CHARGED.

Cut-Out Solenoid Operating Voltage

1. Disconnect lead at regulator "ammeter" terminal (fig. 14).

2. Connect a jumper lead across actuating relay contact points so that points are short circuited (fig. 14).

3. Connect a test voltmeter between "armature" terminal and "ground" terminal on regulator (fig. 14).

4. Run generator and increase speed slowly, noting voltage necessary to close contact points. Allow generator speed to decrease and note voltage at which contact points open. Refer to "Specifications" later in this section, for opening and closing voltage settings. If unit does not operate within specified range, the solenoid plunger spring should be removed and tension increased or decreased to obtain the correct voltage setting.

Actuating Relay Operating Voltage

1. Connect a test voltmeter between "armature" and "ground" terminals (fig. 15).

2. Disconnect battery lead at "ammeter" terminal and connect a 120 ampere ammeter between "ammeter" terminal and battery lead (fig. 15).

3. Start generator and slowly increase speed, noting voltage necessary to operate the relay. Refer to "Specifications" later in this section for operating voltage.

4. To adjust, loosen lock screw and turn eccentric screw to change spiral spring tension. Increasing tension increases voltage setting, decreasing tension lowers voltage setting.

5. Tighten lock screw and again check setting by reducing generator speed then increasing to note voltage setting.

6. As generator speed is reduced note amperes of reverse current and voltage at which points open. Refer to "Specifications" later in this section for operating data.

Current Regulator Current Setting

1. Connect a test ammeter into circuit at regulator "ammeter" terminal, and bridge field relay contact points with a jumper lead to prevent it from operating (fig. 16).

2. Turn on lights or other electrical accessories to prevent high voltage. Operate generator at medium speed. When regulator has reached operating temperature, note current read-

ing. Refer to "Specifications" later in this section.

3. To adjust, loosen lock screw and turn eccentric screw to change spring tension. Increasing tension increases current setting, decreasing tension lowers setting.

4. After tightening the lock screw, check the current setting by stopping generator and then bringing it back to speed again.

HIGH POINTS ON FIVE UNIT REGULATOR PERFORMANCE AND CHECKS

1. Never close the cut-out solenoid contacts by hand with the regulator connected to the battery.

2. Never adjust the voltage regulator setting below the actuating relay setting.

3. Regulator settings must be made with the regulator at operating temperature (135° - 145°F.).

4. Be sure the battery to which the regulator is connected has the proper terminal grounded as stamped on the regulator model plate.

5. After making any regulator electrical adjustment, check the setting by stopping the generator and then bringing it back to speed.

6. Be sure the rubber gasket is in place in the regulator cover to prevent dust from entering the regulator.

7. The voltage regulator unit is precision set and in operation controls the action of the field relay.

8. The field relay inserts resistance into the generator field circuit as its points open to cause a lowering of the generator output in accordance with the condition of charge of the battery and the connected load.

9. The actuating relay is precision set and in operation actuates the cut-out solenoid.

10. The cut-out solenoid makes and breaks the circuit between the generator and the battery.

SPECIFICATIONS

Make	Delco-Remy
Model	005620
Generator (Model)	1117566
Field Relay*	
Air Gap	0.010"
Open Circuit Voltage	8
Voltage Regulator*	
Air Gap	0.018"-0.020"
Point Opening	0.005"-0.008"
Voltage Setting-Open Circuit (1275 R.P.M.)	14.6
Cut-Out Solenoid	
Point Opening	0.050"
Closing Voltage	9.0
Opening Voltage	4.0
Actuating Relay	
Air Gap	0.050"-0.060"
Point Opening	0.020"
Closing Voltage	13.5
Opening Voltage @ 7.0 Amps. (Reverse Current)	12.8
Current Regulator	
Point Opening	0.012"-0.015"
Current Setting-Amps. @ 13.0 Volts	120

*Be sure field relay is adjusted before attempting to adjust voltage regulator.

REGULATOR

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference--make note of bulletin number in space below:

NOTES

Lighting System

Contents of This Section

Related Subjects in Other Sections

Circuits for all lights are shown on the Wiring Diagram in Wiring (Sec. 7A of this manual). Fuses for lighting circuits are also listed in that section, and in addition, fuses are listed in Operation (Sec. O of this manual).

IMPORTANT: All lights should be checked daily and necessary replacements made immediately. Bulb sizes are listed in "Specifications" at end of this section.

SWITCHES AND FUSES

Light switches for all exterior and interior lighting equipment except driver's light, engine compartment lights, stop lights, and tell-tale lights, are located in instrument panel in front of driver. Baggage compartment lights are controlled by a master switch on instrument panel and by individual switches in baggage compartment.

Fuse panel located on back of instrument panel is accessible by removing cover plate below instrument panel switches. Fuse panel contains fuses for all lighting equipment except engine compartment lights. Fuse for engine compartment lights is mounted in engine compartment.

EXTERIOR LIGHTING EQUIPMENT

HEADLIGHTS

Headlight (fig. 1) is double filament "Sealed Beam" type. The lens, reflector, and bulb constitute a complete unit and can be replaced only as such. If lens is cracked, bulb burned out, or reflector damaged, replace complete unit.

Switch marked "Head" controls headlights while foot dimmer switch in floor permits selection of either upper or lower beam. Tell-tale light on instrument panel marked "Hi-Beam" is illuminated when upper beam is used.

Proper Use of Headlights

Headlights are designed to provide adequate highway lighting for normal operating conditions. The headlights will provide safe lighting, providing they are aimed correctly, equipped with proper Sealed Beam units, lens are clean, and upper and lower beams are used correctly.

1. Upper Beam. High beam should be used only on unlighted roads when no approaching vehicles are near.

2. Lower Beam. Lower beam should always be used when approaching another vehicle. The depressed beam provides safer road visibility than upper beam under passing conditions, providing both vehicles use the depressed beam.

3. Headlight Lens. Dirt on lens absorbs a considerable amount of light. Clean lens with water and a good glass cleaner whenever dirty.

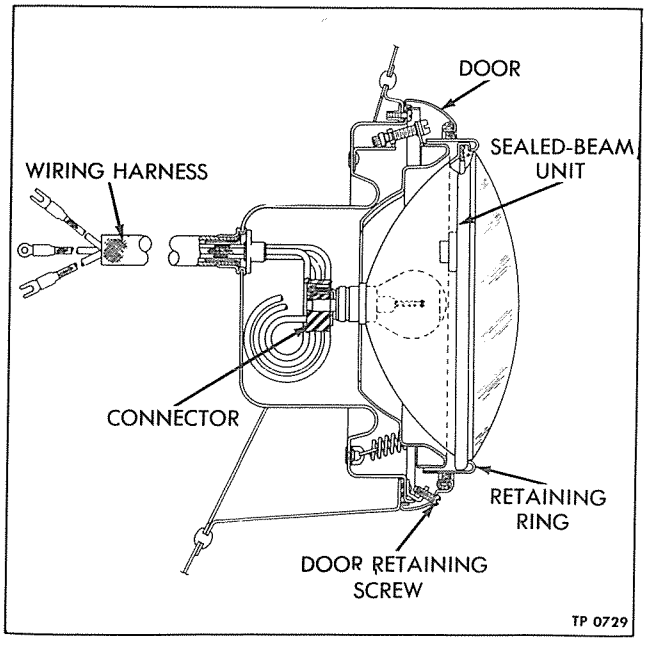


Figure 1—Headlight Assembly

LIGHTING SYSTEM

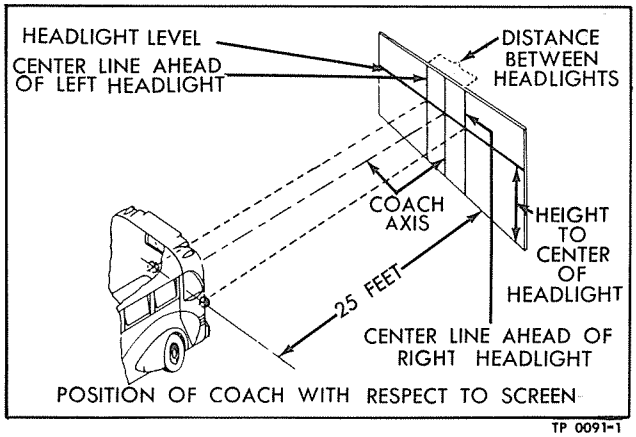


Figure 2—Headlight Aiming Chart

4. Headlight Wiring. For maximum illumination proper voltage must be obtained at the bulb. Discharged battery, loose or dirty electrical contacts in wiring system and poor ground connection all contribute to a decrease in voltage. Check wiring and connections regularly, make sure generator is charging sufficiently, and keep battery properly charged.

Sealed Beam Unit Replacement

Headlight sealed beam unit may be replaced in following manner:

1. Remove rim retaining screw and remove rim.
2. Remove three retaining screws.
3. Pull sealed beam unit out of light body, disconnecting wiring as unit is removed.
4. Insert prongs of new sealed beam unit into wiring plug, then position unit in light body.
5. Install sealed beam unit retaining ring and attach to light body with three screws.
6. Install door with clip engaging slot at top of light body. Install door retaining screw at bottom of door, tightening screw firmly.

Headlight Adjustment

Headlights must be aimed carefully and accurately to assure safe vehicle operation at night. Adjustments can be made quickly and accurately with a headlight tester, but if such equipment is not available, adjust lights as follows:

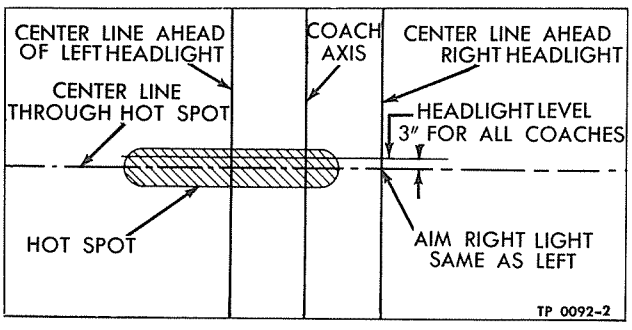


Figure 3—Headlight Beam Pattern

1. Position vehicle on level floor with headlights 25 feet from a vertical wall or door as shown in figure 2. Vehicle center line must be perpendicular to vertical surface.
2. Draw a horizontal line on vertical surface at height of light center as shown in figure 2. Locate a point on this horizontal line at which projected center line of chassis intersects. Measure distance between light centers and divide the distance equally on either side of center mark. Then draw a vertical line directly ahead of each light center as shown.
3. Switch on high or bright beam in headlights and cover one light while adjusting other.
4. Remove door retaining screw (fig. 1), and door for access to adjusting screws. Top screw provides vertical adjustment and side screw aims light horizontally.
5. Beam pattern should approximate that shown in figure 3. A distorted beam pattern is usually caused by a sprung reflector in which event sealed beam unit must be replaced.
6. After headlight is properly aligned, cover its beam and proceed in same manner as above with opposite light.

HEADLIGHT DIMMER SWITCH

Foot-operated headlight dimmer switch, mounted in driver's floor at left side, is attached to switch mounting plate with two bolts.

Switch requires no maintenance; however, switch may be replaced by removing two mounting bolts, after which switch is readily accessible from underneath front of vehicle.

When installing switch, connect wires to terminals before attaching switch to mounting bracket.

IMPORTANT: Brown wire with black and red check must be connected to terminal on switch marked "BAT;" Connect other two wires to remaining terminals; position of these wires with respect to terminals is not important.

FOG LIGHTS

Fog lights are mounted in recessed pockets in front end panels between headlights. A special bulb with a metal fog cap to prevent glare from direct rays, and an amber lens are identifying characteristics of this type of light.

"Fog" switch on instrument board energizes fog light circuit. With "Fog" switch turned on, lights can be turned off and on by foot-operated switch in floor ahead of driver's seat.

Light Bulb Replacement

1. Remove fog light door retaining screw, then remove door (fig. 4).
2. Remove three retaining ring screws, then remove retaining ring and lens.
3. Press in on bulb, at some time turning bulb counterclockwise to remove bulb.
4. Position new bulb in light with prongs engaged in holes in bulb flange. Due to prong spacing bulb can be installed in only one position.
5. Press bulb in firmly, turning bulb clockwise at the same time. Make sure all prongs are properly engaged.
6. Install lens, retaining ring, and three retaining ring screws.
7. Install door, engaging clip on door in slot at top of light body. Fasten door with retaining screw.

Fog Light Adjustment

Refer to "Headlight Adjustment." Fog lights are adjusted in same manner as headlights, however beam pattern differs from headlight pattern. Fog light "hot spot" is more concentrated around center line of light, and "cut-off" at top of beam is more sharply defined than on headlights.

MARKER LIGHTS

Front and rear combination marker and clearance lights are attached to body at roof corners. Light bulbs are accessible by removing two lens retainer screws, lens retainer, and lens.

Front Michigan marker lights, mounted on front roof panel above destination sign are same type as corner lights.

Rear Michigan marker lights are mounted on rear roof panel in center of coach. Bulbs are accessible by loosening clamp ring screw and nut, and then removing clamp ring and lens.

All marker lights are controlled by "Marker" switches on instrument board.

TAILLIGHTS

Taillights are mounted in housings attached to engine compartment side doors, as shown in figure 3 in Operation (Sec. O, of this manual).

Taillights are controlled by "Marker" switch on instrument board. Light bulbs are accessible for replacement by removing two screws which attach door to body of light, then removing door from body.

TARGET SIGN LIGHTS

Four light bulbs, illuminating target sign are controlled by "Marker" switch on instrument board.

Light bulbs can be replaced after removal of stop light in center of target sign. Target sign

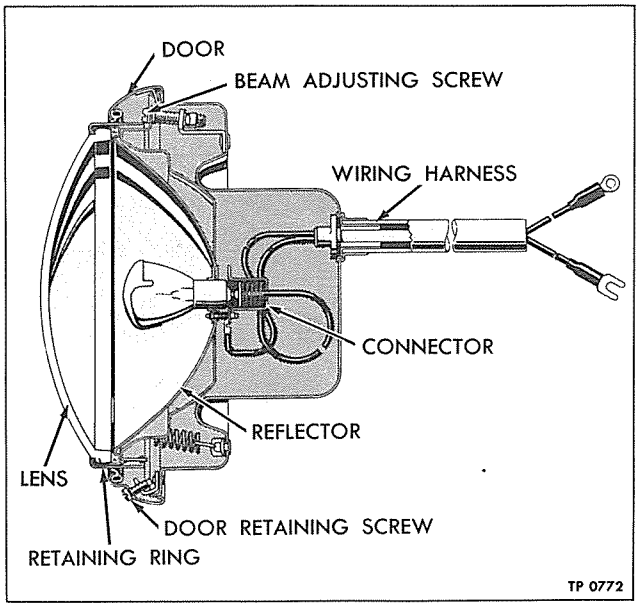


Figure 4—Fog Light Assembly

seal and insert are same type used for windshield, rear windows, etc. Directions for removal and installation of insert and seal are given under "Glass Replacement" in Body (Sec. 3 of this manual).

LICENSE PLATE LIGHT

License plate light, mounted at rear of vehicle directly over the rear license plate holder, is controlled by "Marker" switch on instrument panel.

Bulb is accessible for replacement by removing light cover, cap, and glass.

DESTINATION SIGN LIGHTS

Three lights for illumination of front destination sign are mounted inside destination sign door.

Bulbs are accessible for replacement by opening destination sign door.

Destination sign lights are controlled by "Sign" switch on instrument panel.

STOP LIGHTS

Stop lights are mounted in housing attached to engine compartment side doors and in rear target sign.

Stop light bulb is accessible for replacement after removal of light door, which is attached to body of light with two screws.

Stop Light Switch

Stop lights are controlled by an air-operated switch (fig. 5) connected in the brake system. Relative location of switch is shown in Air Brakes (Sec. 4B of this manual), while electrical circuit is shown in Wiring (Sec. 7A of this manual).

LIGHTING SYSTEM

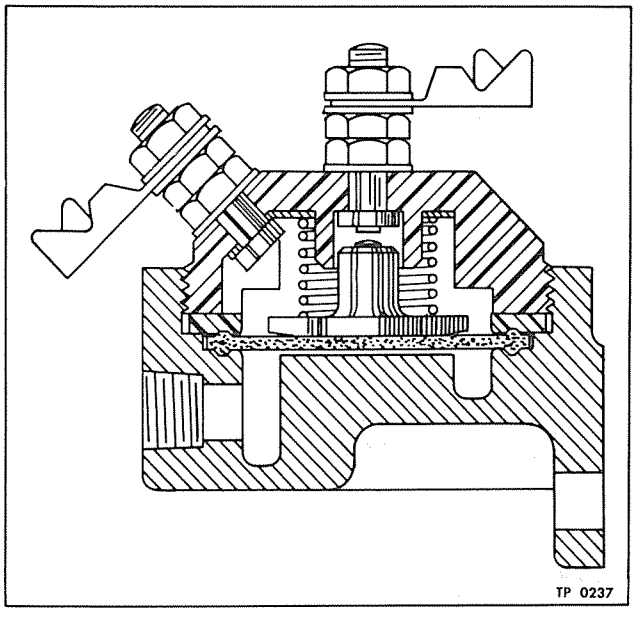


Figure 5—Stop Light Switch

Contact point portion of switch is threaded into body of switch to permit disassembly for inspection of points and diaphragm. At regular intervals check contact points for corrosion or pitting. If such condition is found, file points lightly with a distributor point file to assure proper electrical contact. Whenever contact points are inspected, also examine condition of diaphragm in switch, replacing diaphragm when necessary.

Tell-tale on instrument board marked "Stop" is lighted when stop lights are illuminated. Tell-tale is controlled by a relay, located in tool compartment at front of vehicel, connected in stop light circuit. Tell-tale will not operate if both stop light bulbs are burned out, nor if stop light bulbs, of lower candlepower than listed in "Specifications," are used.

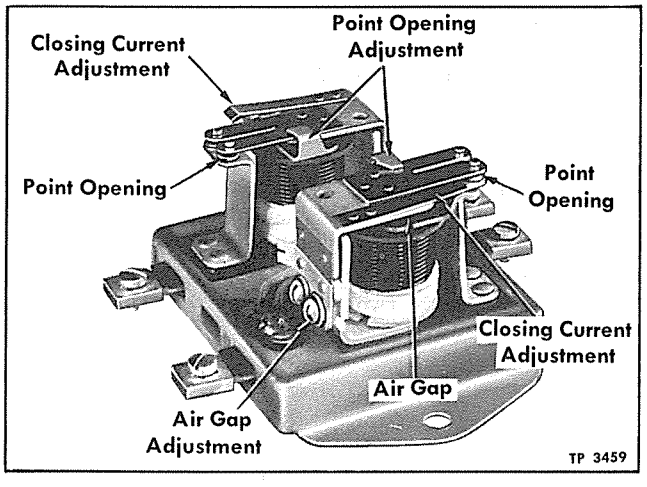


Figure 6—Stop Light Relay

STOP LIGHT RELAY

Stop light relay (fig. 6) is mounted on buzzer and relay panel located in dash compartment. Relay completes stop light tell-tale circuit to indicate to driver that stop lights are operating.

Operating coils of relay are connected in series with the stop light circuit. When brakes are applied, pressure in brake lines closes stop light switch completing stop light circuit. Current flow through stop light circuit energizes relay to close contact points which completes tell-tale circuit.

Should stop light bulb burn out, or other open circuit occur, relay will not operate and tell-tale will not light. Failure of tell-tale to light with brake application is an indication of possible failure of stop lights.

Buzzer and relay panel, on which stop light relay is mounted, is illustrated in Wiring (Sec. 7A of this manual). Wiring Diagrams in that section illustrate electrical circuit. Refer to "Specifications" at end of this section for mechanical and electrical settings of relay.

Relay is accessible for inspection and adjustment after removal of cover screw. When adjusting relay always follow the sequence of adjustment listed in following paragraphs:

Air Gap Adjustment

With the contact points closed, measure the air gap between the armature and center of core. Adjust air gap by loosening two screws and move armature up or down as required (fig. 6). If necessary, align the support carrying the lower contact so that the air gap will be uniform between the core and the armature. Refer to "Specifications" at end of this section for gap.

Point Opening Adjustment

Measure contact point opening with armature in open position. Adjust by bending armature stop (fig. 6). Refer to "Specifications" at end of section for correct point opening.

Closing Current Adjustment

Connect an accurate ammeter and variable rheostat in series at the No. 4 terminal. Close stop light switch and adjust rheostat for proper current flow, listed in "Specifications" at end of this section. Note the ammeter reading as contact points close. Adjust by bending spring post to increase or decrease tension on armature (fig. 6). Increased tension increases amperage at which points close. Decreased tension decreases closing amperage. Repeat procedure with test equipment connected to No. 5 terminal.

If the relay does not function properly during normal operation in vehicle, the candle power of stop light bulbs should be checked. Stop light bulbs of proper size must be used; otherwise, tell-tale light circuit may not function properly.

Circuit Continuity

Connect one prod of test light to No. 1 terminal of relay and other prod to ground. Close both sets of relay points manually. If test lamp fails to light, relay circuit is open and location of open circuit can be found by performing tests as given under "Open Circuit Tests."

Open Circuit Tests

Connect one prod of test lamp to No. 5 terminal of relay and other prod to ground. If test lamp fails to light, relay coil is open circuited. Repeat proceedure with test light connected to No. 4 terminal of relay.

DIRECTIONAL SIGNAL LIGHTS

Directional signal lights, mounted at front corners of vehicle, and in housings attached to engine compartment side doors, are used to signal to drivers of other vehicles, the direction in which vehicle will turn. Electrical circuit is shown in Wiring. (Sec. 7A of this manual).

Signal light bulbs are accessible for replacement after removal of lens and rim which are attached to light body with two screws.

Lights are controlled by switch in bracket attached to steering column. Circuit breaker (flasher) causes signal lights to flash off and on automatically. Tell-tale light in switch bracket flashes in synchronism with directional lights.

Tell-tale light bulb is accessible for replacement by pulling bulb and socket free from holder from underneath bracket. Bulb can then be easily removed from socket.

SPOT LIGHT

Spot light is mounted through front corner post at left of windshield. Beam is directed by a handle, which also contains light switch, from inside vehicle.

Light bulb is accessible by removing lens clamp ring and lens.

INTERIOR LIGHTING EQUIPMENT

INSTRUMENT PANEL LIGHTS

Instruments in instrument panel are illuminated by lights controlled by "Marker" switch in instrument panel.

Light bulbs are accessible by pulling bulb socket free from back of instrument panel. Bulb then can be easily removed from socket. After replacing bulb, press socket firmly into holder in back of socket.

STEPWELL LIGHTS

Front entrance door stepwell is illuminated by two lights, one mounted in tool compartment door and one mounted in vehicle door. Light circuit is energized with "Step" switch turned on, circuit being completed by a switch actuated by door operating mechanism. Consequently, lights operate only with "Step" switch turned on and with front entrance door opened. Lights are designed to illuminate both the lower step of vehicle, as well as the ground below the step for the safety and convenience of passengers entering and leaving vehicle.

Bulbs may be replaced, by removing socket in back of lamp on tool compartment door. Bulb in door is exposed and can be readily replaced.

Stepwell Light Switch

Switch is actuated by stud which is retained on door operating rod by a clamp. When door is opened, stud releases pressure on switch plunger thus closing step light circuit. When door is closed, stud forces switch plunger into switch body and circuit is opened.

Whenever switch is replaced or door operating mechanism is adjusted, switch operating mechanism should be checked and adjusted if necessary.

Clamp and stud assembly is accessible for adjustment through safety equipment compartment door. Adjustment is made as follows:

1. Open compartment door and observe movement of clamp and stud assembly as vehicle door is opened and closed.
2. Loosen clamp bolt, which retains clamp on door operating rod, and move clamp and stud on rod until stud releases light switch plunger just before vehicle door is completely opened.
3. Make sure stud contacts switch plunger firmly when vehicle door is closed, then tighten clamp bolt to lock adjustment.

NIGHT LIGHT

Night light is a low candlepower, blue bulb contained in the second from rear indirect dome light (both sides), connected to a separate circuit controlled by "Sign" switch in instrument board.

DOME LIGHTS

Dome lights are flush mounted on top of package rack outer moulding and are controlled by "Indirect" switches on instrument panel.

Remove two screws from lens retainer, then remove lens and retainer for access to light bulbs.

READING LIGHTS

Reading lights are flush mounted on underside of racks and in roof trim at rear of coach. When switch marked "Rear Marker" on instrument panel is turned on, individual switches at each reading light permit passenger control of lights.

Each light has two switches and three bulbs, except rear center light which has one bulb. Bulbs are accessible for replacement by removing lens and lens retainer.

LIGHTING SYSTEM

DRIVER'S LIGHT

Driver's light, mounted on trim panel above driver's window is controlled by driver's light switch. Refer to Wiring (Sec. 7A of this manual) for Wiring Diagram.

Bulb is accessible for replacement by removing lens and retaining rim which are attached with three screws.

TELL-TALE LIGHTS

Tell-tale lights are provided to warn driver of certain conditions, as follows:

1. "Stop" tell-tale is illuminated when brakes are applied. If tell-tale fails to light with brake application, check stop light, tell-tale bulbs, circuit, relay, and stop light switch to determine cause.
2. "Door" tell-tale, which lights when emergency door is not properly closed, is operated by a switch at emergency door lock.
3. "Hi-Beam" tell-tale is illuminated when country or upper headlight beam is used.
4. "Low-Air" tell-tale lights when pressure in air system becomes too low to operate brakes efficiently.
5. "Low Oil Pressure" tell-tale is illuminated when engine oil pressure falls below safe minimum operating pressure.
6. "Hot Engine" tell-tale lights when engine temperature rises beyond a safe operating temperature.

Tell-tale bulbs are accessible for replacement by pulling bulb and socket free from back of panel. Bulb then can be easily removed from socket. After replacing bulb, press bulb and socket firmly into holder in back of panel.

BAGGAGE COMPARTMENT LIGHTS

Baggage compartments are illuminated by six lights controlled by switch marked "Baggage" on instrument panel, one light being mounted at each door. Each light is controlled by a separate switch mounted in such manner that opening and closing compartment door automatically turns switch on and off, when "Baggage" switch is on.

Bulbs are accessible for replacement by removing lens retainer, which is attached with three screws.

ENGINE COMPARTMENT LIGHTS

Power plant units are illuminated by two lights controlled by a switch in the engine compartment control box inside right rear closure door.

Bulbs are readily accessible for replacement.

SPECIFICATIONS

All light bulbs listed below are of 12-16 volt rating.

UNIT	CONTACT	C.P.	TRADE NO.
Headlights - Sealed Beam Unit			4430
Hi-Beam		45 Watts	
Low-Beam		35 Watts	
Fog Lights	SC	32	1011
Marker Lights	DC	3	68
Rear Michigan Marker Lights	DC	3	68
Taillight	SC	3	67
Target Sign Lights	DC	3	68
License Plate Light	SC	3	67
Destination Sign Lights	DC	6	90
Stop Lights	SC	15	93
Directional Signal Lights	SC	21	1141
Instrument Panel Lights	SC	3	67
Step Light (Door)	DC	21	1142
Step Light (Stepwell)	SC	21	1141
Night Light	SC	3	67 (Blue)
Dome Lights	SC	15	93
Reading Lights	SC	15	93
General Lighting Light	SC	6	89
Driver's Light	SC	15	93
Baggage Compartment Light	DC	6	90
Engine Compartment Light	SC	15	93
Tell-tale Lights	DC	3	68

Stop Light Relay

Make	Delco-Remy
Model	1116849
Air Gap (Points Closed)	0.014"
Point Opening	0.015" - 0.025"
Armature Attracted to Core (Amps.)	
Points Open	1.1
Points Closed	1.6

Engine Tune-up

Contents of This Section

Related Subjects in Other Sections

Refer to Diesel Engine Maintenance Manual Form X-4517

Results obtained from an engine tune-up may be unsatisfactory if a "hit and miss" method is used instead of a systematic approach to the job; therefore, the logical solution is a complete check-up following the cycle in the accompanying illustration and carrying out each step as directed below.

NOTE: Before tune-up procedure is started it is important that air cleaner is serviced as shown in its respective section of this manual, also crankcase breather tube and air box drains must be clean and unobstructed. Air box drains may be cleaned with compressed air.

CAUTION: Remove or at least loosen an air box hand hole cover, else blower or end plate gaskets may be damaged by excessive air pressure.

Reference should be made to "Trouble Shooting" (Sec. 17, page 14 of Diesel Engine Maintenance Manual Form X-4517) for engine operatting trouble symptoms and causes.

COMPRESSION TEST

Compression test is beneficial in determining the need of internal repairs before tune-up procedures are accomplished. This test will indicate condition of pistons, rings, and valve mechanism.

For instructions on how to perform compression test, refer to Diesel Engine Maintenance Manual form X-4517, section 17, page 15.

TUNE-UP SEQUENCE (Refer to Fig. 1)

Following is sequence in which tune-up operations MUST be performed.

No detail instructions are given here, but rather reference is made to the Diesel Engine Maintenance Manual, form X-4517.

1. Lash exhaust valves (Sec. 11, page 2).

2. Set injector timing (Sec. 15, page 12).

3. Set governor spring plunger gap (Sec. 15, page 14).

4. Adjust injector rack control levers (Sec. 15, page 15).

5. Adjust engine idling speed (Sec. 16, page 14).

6. Adjust governor buffer spring screw (Sec. 16, page 14).

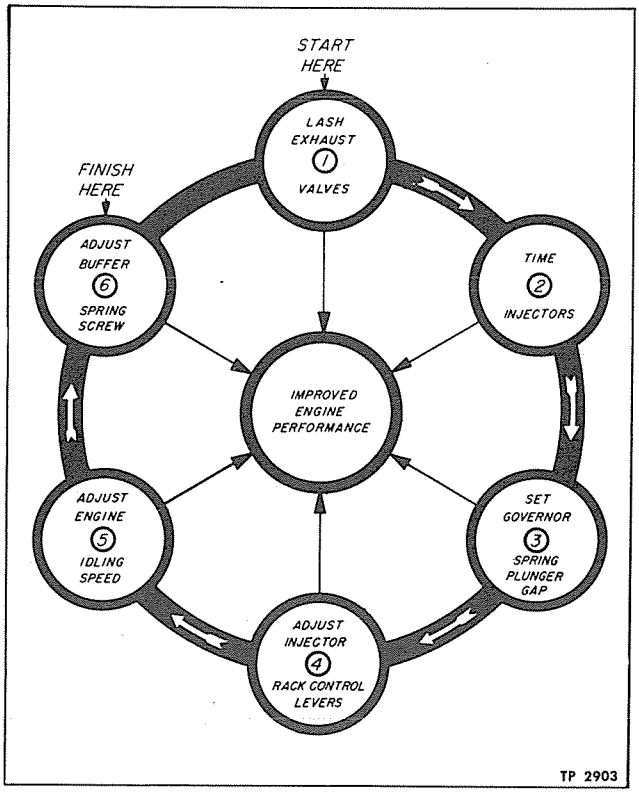


Figure 1—Engine Tune-up Chart

ENGINE TUNE-UP

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the test and bulletin filed for future reference -- make note of bulletin numbers in space below:

NOTES

Diesel Engine

Contents of This Section

Related Subjects in Other Sections

Refer to Diesel Engine Maintenance Manual (Form X-4517)

Diesel engine used in vehicles covered by this manual is the six cylinder, two cycle, GM Series 71. Refer to "Specifications" at end of this section for further data.

Description, operating instructions, engine tune-up, trouble shooting, maintenance, and repair for this engine are contained in a separate maintenance manual for Series 71 Diesel engine (form No. X-4517).

Certain instructions such as operation, engine tune-up adjustments, etc., as well as accessories peculiar to these vehicles are covered in their respective sections within this manual. Reference should be made to the respective sections of this manual before referring to the Diesel manual.

OIL PRESSURE GAUGE

Oil pressure gauge system consists of two electrically connected units; an engine sending unit mounted in engine pressure lubrication system and a registering gauge mounted in instrument panel. Oil pressure gauge system is interconnected with control switch so that system is inoperative when switch is in "off" position. Refer to wiring diagrams in Wiring (Sec. 7A of this manual) for electrical circuit.

TESTS

If oil pressure gauge does not operate, or shows apparent false readings, with control switch turned on, check system as follows:

1. Check No. 2 fuse to see if it is burned out.
2. If not, disconnect wire at engine unit terminal.
3. Connect one end of a 1.5 candlepower 12 volt test lamp to battery terminal on starter solenoid. Touch other lead to body of engine sending unit. If bulb lights, unit is properly grounded. If bulb does not light, check for presence of sealing compound around threads of unit. Remove compound and repeat test.
4. Remove test lamp lead from body of unit, and touch lead to terminal on unit. If bulb lights, engine unit is shorted and must be replaced.
5. Remove test light and reconnect wire from gauge unit to engine unit terminal.
6. Test wiring and units for current flow. Use test lamp as follows:

a. Connect one wire of test light to terminal on engine unit to which wire from control switch is connected. Connect other wire of test light to ground. If bulb fails to light, check wiring for open circuit.

b. Connect one wire of test lamp to gauge terminal to which engine unit is connected, and other test light wire to ground. Replace engine unit if bulb fails to light.

c. Connect test lamp between other gauge terminal and ground. Replace gauge if bulb does not light.

7. If system still fails to function, trouble must be in the actuating elements of either engine or gauge units or both and condition can be corrected by installing new unit in either or both of two positions.
8. Do not attempt to repair either engine or gauge units. When installing new engine unit, do not use thread sealing compound on threads as this will increase electrical resistance of unit and cause faulty reading on gauge.

LUBRICATING OIL STRAINER AND FILTER

Diesel engine used in vehicles covered by this book are equipped with a cleanable type oil - strainer and a replaceable, non-cleanable element - type filter.

OIL STRAINER

The oil strainer, illustrated in figure 1, incorporates a cleanable type element through which

DIESEL ENGINE

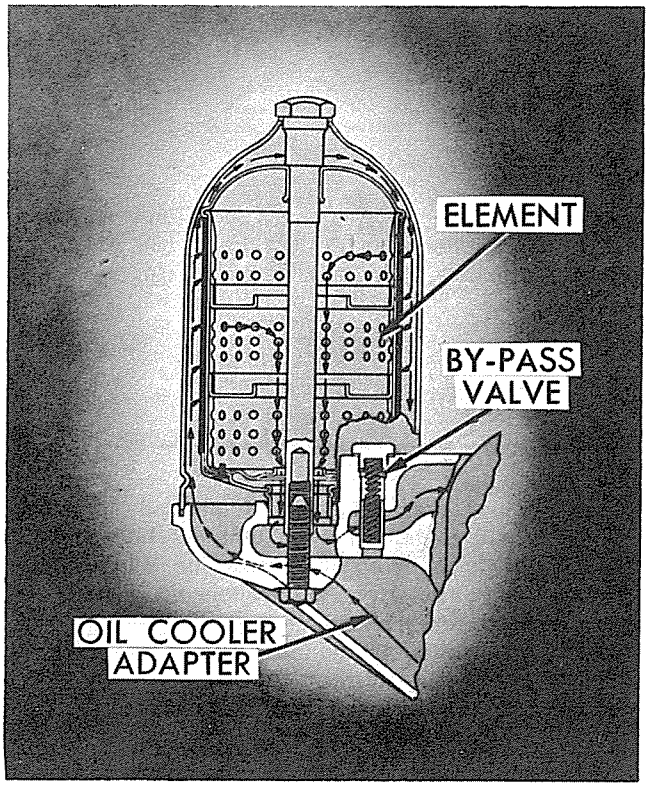


Figure 1—Sectional View of Oil Strainer

all the oil leaving the oil pump passes. Strainer removes all particles larger than .005" in diameter.

Strainer element must be thorough cleaned at each oil change. If strainer is not cleaned, it will eventually become restricted or even clogged; then flow of oil is by-passed around strainer and oil cooler as well. Under these conditions oil will not be strained or cooled and serious damage to engine may result.

CLEANING OIL STRAINER

1. Remove strainer drain plug and allow oil to drain from strainer.
2. Unscrew oil strainer through-bolt then lift off strainer housing and element.
3. Wash inner and outer surfaces of element in clean fuel oil, or other suitable cleaning fluid, using a fine bristle brush. Do not use a wire brush. Be sure element is thoroughly clean.
4. Wash other strainer parts as well, making certain all parts of the strainer are clean before reassembling unit, also that gaskets at either end of housing are in place and in good condition.

OIL FILTER

The oil filter, illustrated in figure 2, incorporates two replaceable, non-cleanable filtering elements through which only a metered portion of the circulated oil passes. This filter removes abrasive matter, sludge, wax, and other substances detrimental to the engine. Filter elements must be discarded and replaced with new elements at each oil change; otherwise the new oil will become contaminated, and eventually flow of oil through filter will cease resulting in possible serious damage to engine.

CLEANING OIL FILTER

1. Remove filter drain plug and allow oil to drain from filter.
2. Unscrew oil filter through bolt then lift of filter housing and elements. Discard elements.
3. Wash filter parts in clean fuel oil or other suitable cleaning fluid.
4. Install a new element and make certain all parts of the filter are clean before reassembling unit, also that gaskets at either end of housing are in place and in good condition.

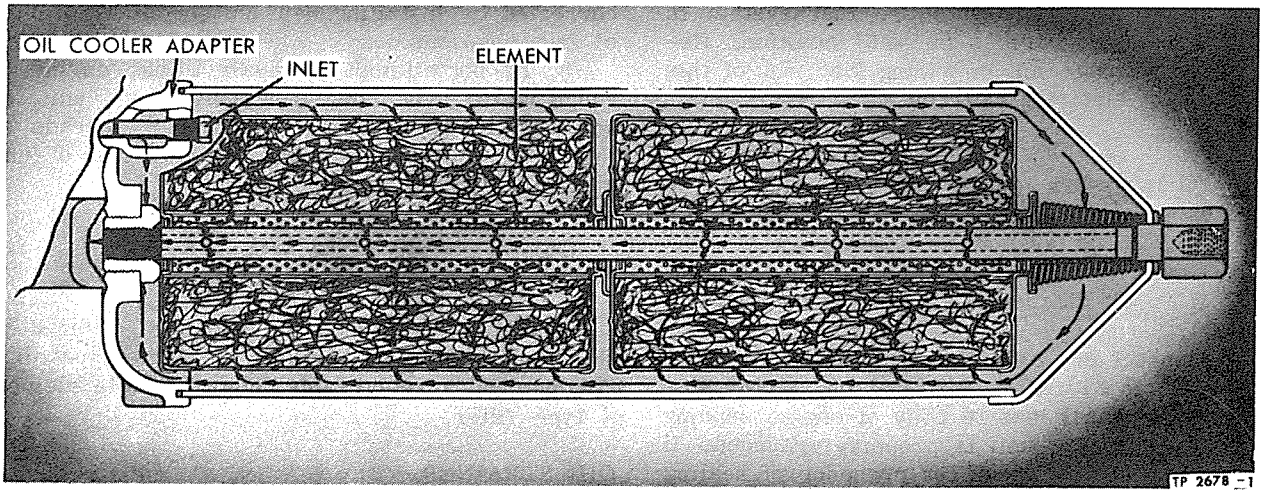


Figure 2—Sectional View of Oil Filter

SOLENOID

A solenoid is an electrical device used to operate a unit to which the solenoid is connected mechanically.

When solenoid is energized, by means of a remote control switch, solenoid plunger is pulled into solenoid coils, thereby operating the unit to which solenoid plunger is attached.

ENGINE STOP SOLENOID

Engine stop solenoid is mounted on engine governor and is connected to governor cam. Solenoid, when energized by means of engine stop switch at instrument panel (also in engine compartment), moves governor cam allowing governor to move injectors into "No-Fuel" position.

MAINTENANCE

Keep all terminals clean and tight. Always check action of solenoid if it has been removed and reinstalled. If solenoid fails to function, check switch and wiring before working on solenoid.

Only test to make on solenoid is to check pull of solenoid coils with suitable equipment. Test specifications are listed under "Specifications" at end of this section.

EMERGENCY STOP SOLENOID

Emergency stop solenoid, mounted on blower intake, is used to release a valve to shut off air supply to engine, thereby stopping the engine. Solenoid is energized by an emergency stop switch at instrument panel, as explained in "Operation" section of this manual. Energizing solenoid pulls solenoid plunger out of notch in valve shaft, thereby permitting spring tension to close valve.

NOTE: Whenever valve is released, engine cannot be started again until valve is reset by hand.

MAINTENANCE

Keep all terminals clean and tight. Always check action of solenoid if it has been removed and reinstalled. If solenoid fails to function, check switch and wiring before working on solenoid.

Only test to make on solenoid is to check pull of solenoid coils with suitable equipment. Test specifications are listed under "Specifications" at end of this section.

ELECTRICAL TACHOMETER

Tachometer is comprised of two electrical units interconnected by an electrical cable. The drive unit (fig. 3) is mounted in the engine compartment of the vehicle and is driven by a short flexible shaft from the engine blower drive shaft. A four-wire conductor cable extends from the drive unit to the motor unit (fig. 4) which is mounted at the instrument panel. Motor unit consists of an electric motor and a mechanical tachometer head.

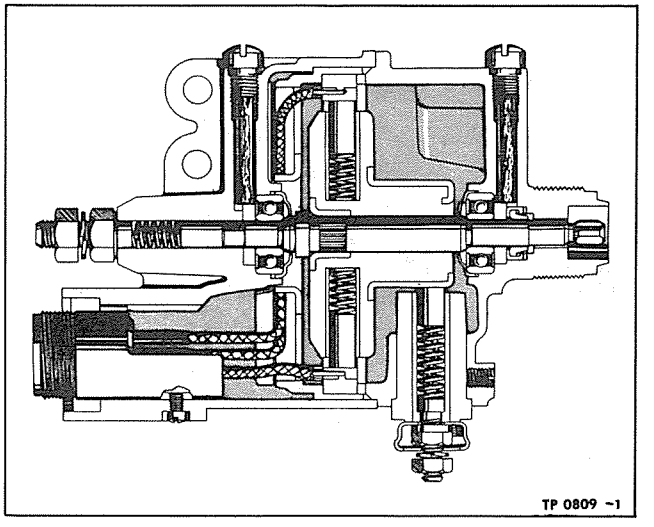


Figure 3—Engine Tachometer Drive Unit

Drive unit uses 12 volt current taken from vehicle electrical system and is interconnected with control switch so that tachometer is inoperative when control switch is in "OFF" position as shown in figure 5. This current is divided in the drive unit by means of a mechanical driven rotor having two brushes which run against a resistor ring. These electrical impulses are transmitted through the four-wire cable to the motor unit where two pair of coils cause a magnetic rotor to rotate at exactly the same speed as the mechanical driven rotor in the drive unit. Since the magnetic rotor is coupled to tachometer head, rotation is transformed to a reading on face of calibrated tachometer head. Thus, a synchronized electrical drive is accomplished.

TESTING

When testing tachometer electrical, units, use a fully charged 12 volt battery. Variation of plus or minus one volt is permissible. The maximum current consumption should not exceed 3.8 amps. when drive unit is stationary; 1.5 amps. when running.

Jam nut, located at point where the four-wire cable conduit fastens to connector plugs, should always be kept tight so that connector plug body grips cable insulation and prevents conduit coming loose from connector plugs due to rough handling.

DIESEL ENGINE

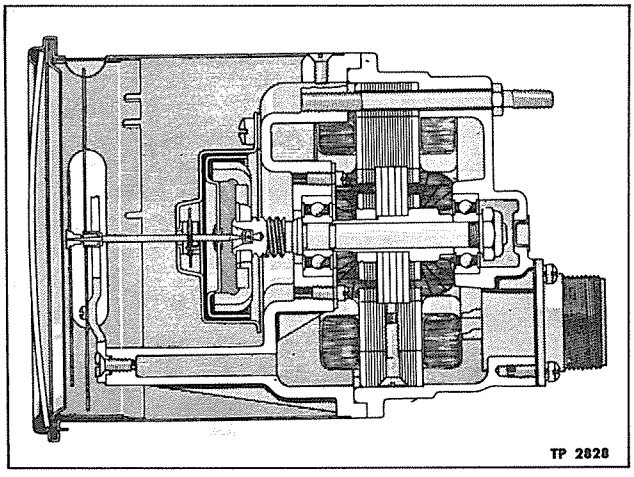


Figure 4—Engine Tachometer Motor Unit

If tachometer fails to function test electric tachometer with test lamp number 1568147 as follows:

1. Check test lamp bulbs with battery to be sure they are not burned out. Check 6 amp. fuse in wire leading from vehicle electrical system to drive unit, refer to Wiring diagram figure 5, to be sure it is not burned out.

2. Pull four-contact plug out of drive unit and insert plug on end of test lamp cable in its place.

3. Turn control switch on to energize drive unit.

4. Disconnect flexible drive shaft at engine blower drive shaft, and turn flexible drive shaft slowly by hand. If test lamp bulbs glow alternately bright and dim, the drive unit is functioning properly.

5. Remove test lamp cable plug from drive unit and reconnect four-wire cable.

6. Disconnect cable plug from motor unit and connect to test lamp cable using double end male adapter chained to end of cable.

7. Again turn flexible drive shaft slowly by hand. If test lamp bulbs glow alternately bright and dim, wiring between drive unit and motor unit is good and trouble should be in motor unit.

8. If test lamp bulbs fail to glow when connected to drive unit, check feed and ground connections at drive unit for tight connections, also check for broken flexible drive shaft.

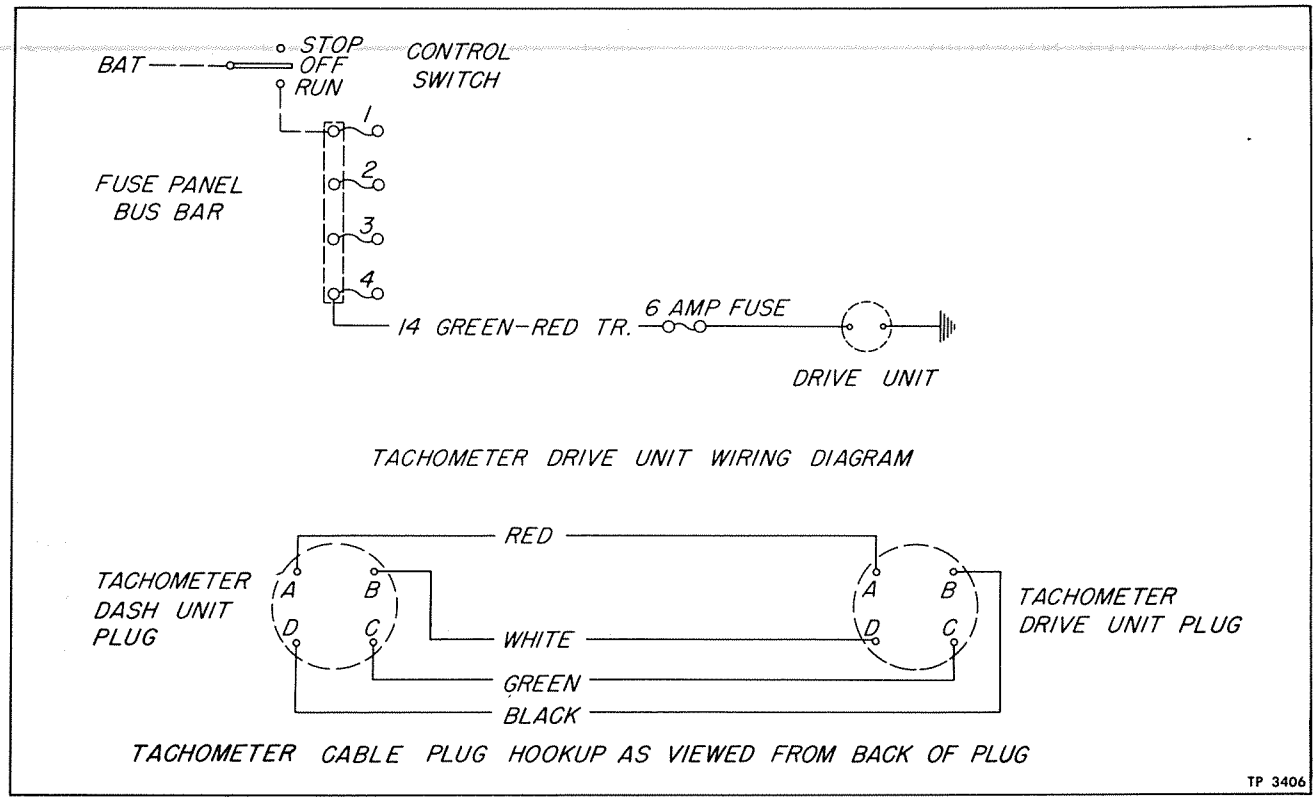


Figure 5—Engine Tachometer Wiring Diagram

9. If test lamp bulbs glow when connected to drive unit but not when connected at front of four-wire cable, make careful check of cable for broken wires or loose connections where wires attach to sockets.

Following above procedure will determine whether trouble lies in drive unit, four-wire cable, or in motor unit.

NOTE: If tachometer calibration is not satisfactory, tachometer head may be recalibrated by an authorized United Motors Service Station. Tachometer calibration descrepancies have no connection with the electric drive unit providing the tachometer head and motor unit are not binding. Binding is indicated by excessive pointer fluctuations.

MOTO-GARD AND TELL-TALE ALARM SYSTEM

Moto-Gard and tell-tale alarm system comprises a group of automatic electrical devices which prevent damage to engine due to loss of oil pressure or excessive coolant temperature by stopping the engine when either of these conditions occur. Operation of this system is explained in Operation (Sec. O of this manual). Maintenance and repair of units included in Wiring and Miscellaneous Electrical (Sec. 7A of this manual).

SPECIFICATIONS

ENGINE DATA
- Model 671LA35
- Bore . . . . . 4-1/4"
- Stroke . . . . . 5"
- Total Displacement - Cu. In. 425.31
- Rotation . . . . . Counterclockwise
- Firing Order 1-4-2-6-3-5

ENGINE STOP SOLENOID
- Make . . . . . Delco-Remy
- Model 991424
- Max. Volts to Close @ 70°F. 4.0
- Current Consumption @ 12 Volts . . . . . (Amps.) 12.0-13.0

EMERGENCY STOP SOLENOID
- Make . . . . . Delco-Remy
- Model 001424
- Max. Volts to Close @ 70°F. 4.0
- Current Consumption @ 12 Volts 12.0-13.0

OIL PRESSURE GAUGE - ON INSTRUMENT PANEL
- Make . . . . . King Seeley
- Type
  - Gauge Unit 7999-2
  - Engine Unit 41500
  - Voltage 6
  - Range . . . . . 0-80 Lbs.

ENGINE TACHOMETER
- Make . . . . . AC
- Model
  - Drive Unit 1567678
  - Motor Unit 1536658

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however, are not supplied by GMC Truck & Coach Division. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

Tool No.	Tool Name
1568147	Electric Speedometer Test Light

Vendor	Address
AC Spark Plug Division	Flint, Michigan

DIESEL ENGINE

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference - Make note of bulletin number in space below:

NOTES

Engine Mounting

Contents of This Section

Related Subjects in Other Sections

(Refer to Diesel Engine Maintenance Manual, Form X-4517)

ENGINE MOUNTING

Diesel power plant, including engine, clutch and transmission is mounted transversely at the rear of coach, as shown in figure 1. Power plant and accessories are accessible for minor service operations through rear and right hand compartment doors. Transmission may also be removed as a unit, independent of engine, to permit service operations on clutch or transmission. Refer to (Sec's. 5 and 17 of this manual) for procedures of the above two units.

Engine compartment switch panel, accessible through right hand rear compartment door, contains starter button, engine stop button, starter circuit cut-out switch and engine compartment light switch. Always shut off starter circuit cut-out switch before working on engine. This prevents accidental starting of engine with starter button, while working on engine.

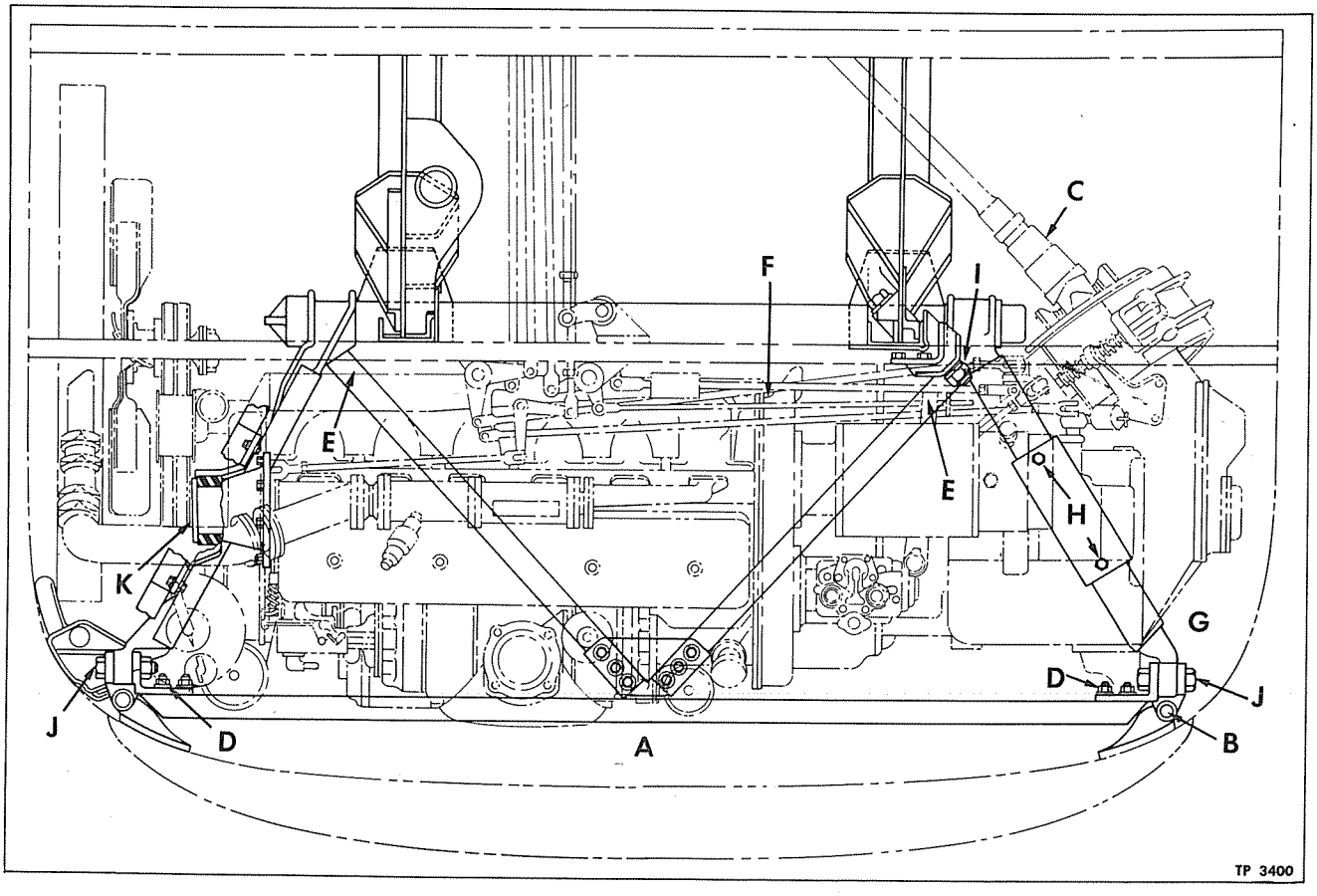


Figure 1—Diesel Engine Mounting

ENGINE MOUNTING

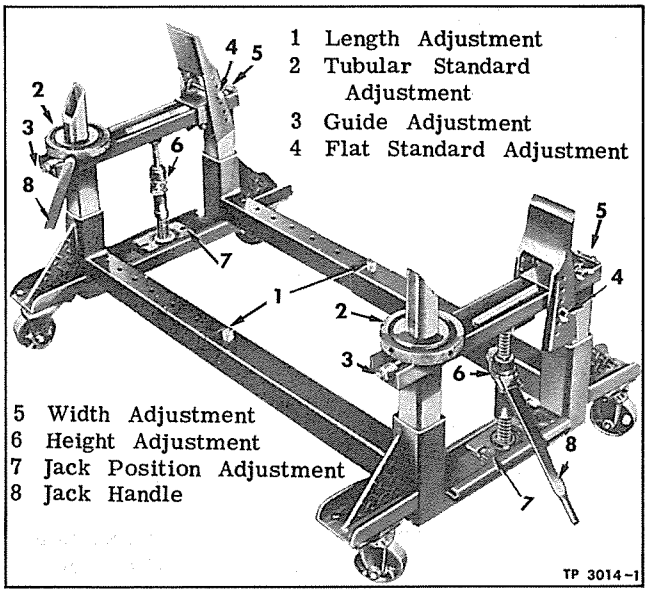


Figure 2—Power Plant Dolly

REMOVING POWER PLANT

Power plant including transmission may be removed from vehicle in following manner: Procedures outlined are in sequence and should be followed in order. Refer to figure 1.

NOTE: Before proceeding with operations as listed, disconnect both battery leads.

1. Unlock right and left hand and center rear doors and transmission inspection door.
2. Shut off engine compartment starter circuit cut-off switch.
3. Remove center rear door to bumper bolts (A). Raise center door and provide a suitable means of holding door fully opened.
4. Remove bumper right hand pin (B) and swing bumper outward away from engine.
5. Unlock engine pan spring at left hand corner, remove bolts and clips at forward edge of pan, and remove pan.
6. Drain cooling system. Two drain cocks must be opened; one at water pump and one under forward radiator water outlet line.
7. Disconnect oil reservoir, oil line at engine balance weight cover, then remove oil reservoir from engine front mounting bracket.
8. Disconnect heater pipes between engine and bulkhead; cooling system between engine and radiator; air intake system between blower and manifold, also generator; compressed air system as necessary; electrical system; exhaust system; hand brake, transmission, clutch, and accelerator control rods; fuel lines and speedometer cable; tachometer cable if used.
9. Unscrew propeller shaft slip joint (C). When engine is removed propeller shaft will separate at slip joint.
10. Remove bumper channel bolts (D) and diagonal brace bolts (E). Remove channel and braces as an assembly.
11. Place special dolly (fig. 2) under engine and raise engine sufficiently to relieve pressure on mounting bolts.
12. Disconnect engine strut rod eye at strut rod bracket (F) on engine.
13. Remove transmission to insulator bolts, (G) at right hand corner strut.
14. Remove transmission to engine support bolts (H) at engine right hand support. Also battery ground strap.
15. Remove transmission insulator to frame bolt nut (I), at bulkhead side of transmission.
16. Unhook and drop transmission dust pan.
17. Remove right and left hand engine support member to right and left hand strut bolt (J) and allow support member to swing down.
18. Remove right hand strut to body frame bolt and remove strut.
19. Remove bolts (K), attaching engine front support insulator to front support.
20. Recheck carefully to be sure that all apparatus from engine to chassis has been disconnected, then withdraw engine through rear of vehicle.

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however, are not supplied by GMC Truck & Coach Division. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

Tool No!	Name	Vendor Code
CS-1421	Engine Dolly	CS
CS-1926	Engine Overhaul Stand	CS

Code	Vendors Name	Address
CS	Curtiss Smith Mfg. Co.	Pottstown, Pa.

Fuel System

Contents of This Section

Related Subjects in Other Sections

FUEL SYSTEM

Description and maintenance of the Diesel fuel injector system, fuel oil pump, fuel oil manifolds, and governor are contained in separate maintenance manual for GM Series 71 Diesel Engine.

FUEL OIL SYSTEM MAINTENANCE

It is important that fuel oil is clean and free from water to assure efficient engine operation. When storing and dispensing fuel oils, it should be handled as described under "Fuel Oil Storage and Handling" later in this section.

FUEL OIL FILTERS

Two fuel oil filters, mounted to a common bracket on the engine (fig. 1), are provided to keep the fuel oil clean and free from water as it enters the injectors. Two small filters are also provided in each injector

The primary or lower of the two fuel oil filters is a cleanable (edge-type strainer) filter, and is designed to remove the larger particles of solid foreign matter and the water which may accumulate.

The secondary or upper filter is a removable element (absorption) type, and is designed to remove all of the solid foreign matter that may have passed through the edge type strainer.

CARE OF FUEL OIL FILTERS

In order for these filters to clean the fuel oil it is highly important that they are given proper care. Service in the following manner:

Primary Filter (Cleanable Type)

Primary filter (fig. 1) must be drained frequently because if water is present in the fuel it is most likely to accumulate in the filter. No definite draining periods can be given here, inasmuch as the necessity for draining depends upon the cleanliness of the fuel put into the fuel tank. It is recommended however, that a small amount of fuel oil be drained from this filter daily, noting the water content (if any), then from this experience definite draining periods may be established. Drain filter by opening drain cock at bottom of filter. If water in any amount is regularly found in this filter, it is an indication that something is wrong in the method of handling and storing of the fuel oil and a thorough investigation should be made to remove the trouble; then the fuel tank, lines and both filters drained and cleaned. The only water that will normally accumulate in the fuel system is from condensation in the fuel tank which will be very little if tank is kept as near full as possible.

Cleaning Primary Filter

In addition to periodic draining as described in preceding paragraph filter should be thoroughly cleaned every 5000 miles as follows:

1. Open drain cock at bottom of filter and allow filter to drain.
2. Unscrew through bolt (at bottom of filter), withdraw housing and edge type filter element.
3. Wash all filter parts, including strainer element, in a suitable cleaning solvent. Be sure all particles are removed from between disk of element. Use air if necessary.
4. Inspect filter housing gasket, element gasket, and through bolt gasket; replace if not in good condition.

FUEL SYSTEM

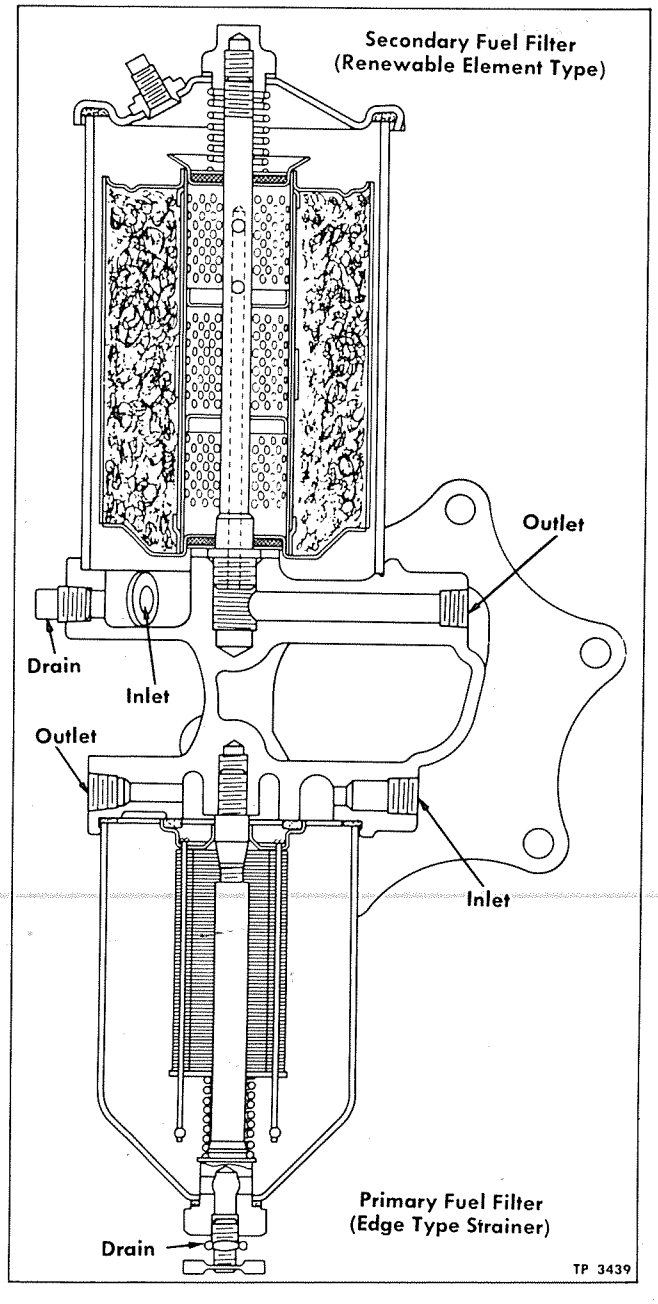


Figure 1—Fuel Filter Installation

5. Reassemble filter and inspect carefully for leaks. Be sure drain cock is closed tightly.

Secondary Filter Renewable Element Type

It is recommended that secondary filter (fig. 1) be drained at same intervals as primary filter. Refer to "Primary Filter" in previous paragraph for intervals.

In addition, to draining the following check should be made at intervals of 1500 to 2000 miles to determine the condition of the element. This check can be made by removing the pipe on the outlet side of the filter and installing a pressure gauge connected to a "tee." Start engine and note pressure on gauge. When the pressure reading is reduced to 15 lbs. at 2000 rpm, the element should be removed and replaced. Do not open the filter except at time of element replacement. Replacement usually will be required every 10,000 miles or 500 hours. DO NOT ATTEMPT TO REMOVE AND CLEAN FILTER ELEMENT.

Replacing Secondary Filter Element

If periodic check, as described in previous paragraph, indicates filter element should be changed, proceed in the following manner:

1. Remove drain plug from filter housing and allow filter to drain.
2. Loosen cover nut, then lift cover and gasket from filter housing.
3. Lift element from filter housing and discard element.
4. Wash all filter parts with a suitable solvent.
5. Install new element in housing and install cover, using a new gasket between cover and housing. Tighten cover nut. Be sure drain plug is installed tightly.
6. CAUTION: After element has been replaced as instructed above, loosen, but do not remove, the square headed plug at top of filter for air vent. Loosen it just enough to allow air to escape. THEN, run the engine until fuel oil comes out of this vent in a solid stream. NEXT, tighten the air vent plug securely. Check the filter connections and oil lines for leaks and tighten if necessary.

FUEL OIL SPECIFICATIONS

The selection of fuel is an important factor in Diesel operation. Selection based on knowledge of the characteristics that govern quality and suitability of fuel oil will lead to more economical and satisfactory performances. Use oil of the following specifications.

PROPERTY	REQUIREMENTS	*A.S.T.M. METHOD
Cetane Number	45 Minimum	D 613
Pour Point	Max. 10°F. Below lowest expected temp.	D 97
Volatility --		
Initial Condensed	320°F. Minimum (Note 1)	
90% Condensed	500°F. Maximum (Note 3)	
End Point or final Boiling Point	550°F. Maximum (Note 3)	D 158 (Note 2)
S. U. Viscosity, 100°F.	30" - 40"	D 445 and D 446
Water and Sediment	0.05% Maximum	D 96
Ash	0.01% Maximum	D 482
Flash Point	120°F. Minimum	D 93
Total Sulphur	0.5% Maximum	D 129
Corrosive Sulphur	Pass Test	D 130 (Note 4)
Carbon Residue	0.2% Max. on 10% Residuum	D 189
Alkali or Mineral Acids	Neutral	D 663 or D 664
Odor	Non-offensive	

Note 1 - Operation under severe conditions in hot weather may necessitate specifying initial condensed point of 335°F. minimum, in order to prevent occurrence of vapor lock and irregular idling.

Note 2 - If kerosene or similar fuel is used, method D 86 applies.

Note 3 - Where fuel as recommended is not available, fuel not exceeding the following limits is suggested: 90% condensed at maximum 600°F. and maximum end point of 650°F.

Note 4 - Test should be conducted at 212°F. instead of 122°F.

*American Society for Testing Materials

TP 3277

FUEL OIL STORAGE AND HANDLING

It is important that extreme care be exercised in the handling and storage of Diesel fuel oil. Absolute cleanliness and the absence of water in the fuel oil is essential to satisfactory operation. It is therefore recommended that wherever fuel oil is stored, adequate filtering equipment be provided. It is suggested that the fuel oil be doublefiltered from storage tank to pump and that filters are properly serviced according to instructions from the filter manufacturer.

In addition to servicing the filters, proper service of the dispensing system requires that approximately every ten days a hand pump be inserted in lowest portion of storage tank to remove the accumulated water and sludge. Some layouts will have a sludge collection pan for removal of dirt and water and hand pump will not be needed.

If fuel oil is obtained and stored in drums without the benefit of the above filtering arrangement, it is necessary that extreme caution be used in handling to assure absolute cleanliness. Drum should be provided with a pump which can be screwed or otherwise properly attached to the fuel outlet hole. Pump should be equipped with a good filter, the element of which can be removed and cleaned or replaced.

It is also advisable to provide a suitable dust cover for end of pump hose when not in used.

FUEL SYSTEM

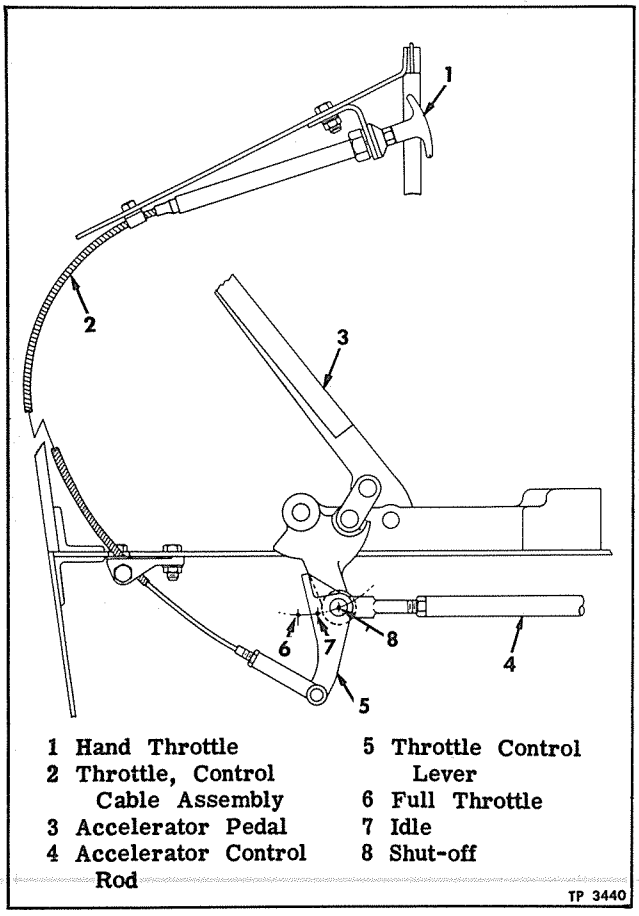


Figure 2—Throttle Hand Control

ACCELERATOR AND HAND THROTTLE

Accelerator pedal is connected to governor by means of rods, linkage and return springs. Adjustable yokes are provided at front and rear end of control rod and at cross shaft at front end of engine, to adjust length of rods.

Whenever engine is stopped, accelerator pedal must be pressed to release injector racks from "No Fuel" position before engine will start.

A ratchet type hand throttle is connected to accelerator linkage, as shown in figure 2, for convenience of operator. Refer to Operation (Sec. O, of this manual) for instructions on how to operate hand throttle.

FUEL TANK AND LINES

Front and rear fuel tanks are mounted before and after rear axle as illustrated in figure 3. Tanks are filled separately through filler necks extending to right hand side of body.

Fuel feed and return lines are special metal tubing and flexible hose. Metal lines are protected where necessary with loom and are securely clipped in place.

A selector valve, connected into the fuel lines as shown in figure 3, permits the fuel supply to be taken from either or both tanks. Selector valve is mounted at forward right hand side of engine compartment and is accessible through transmission inspection door.

INSPECTION

Tank mountings and line connections should be checked regularly and tightened if necessary.

Fuel lines should be checked periodically for distortion or fractures and repaired before leaks occur.

AIR INTAKE AND CLEANERS

Air for engine is taken in through louvered openings at right and left rear corners of body. Air passes through compartment at rear of rear seat into silencer then through air cleaners to engine blower as shown in figure 4.

AIR CLEANER

Three heavy duty oil bath air cleaners are mounted to manifold located at bottom of silencer through engine compartment doors. Cross section of air cleaner is shown in figure 5.

OPERATION

Following description of air cleaner operation shows clearly the necessity of periodic cleaning.

1. Assuming that air cleaner elements have just been cleaned and dipped in oil, and sumps filled with oil to preper level, operation is as follows: When engine starts, air is drawn into cleaners as illustrated in figure 4. Until speed of engine reaches about 100 rpm velocity of air is not sufficient to agitate pool of oil in sumps, but sudden reversal and impact of air stream will divert larger particles of dirt into sumps, and finer particles will be filtered out by oil wetted mesh.

2. As engine speed increases, velocity of air agitates pool of oil, and saturating spray is directed on mesh. Impact and reversal of air stream still throws off larger particles and oil sprayed mesh filters out remaining dirt.

3. As dirt is filtered out of air and settles into sump, oil in sump becomes thicker until it assumes consistency of wet cement if cleaner is not serviced soon enough. This thick substance is sprayed into lower part of mesh until solid mass is formed clogging lower portion so that air flow becomes restricted. Upper part of mesh soon dries out and particles of dirt are drawn through blower.

FUEL SYSTEM

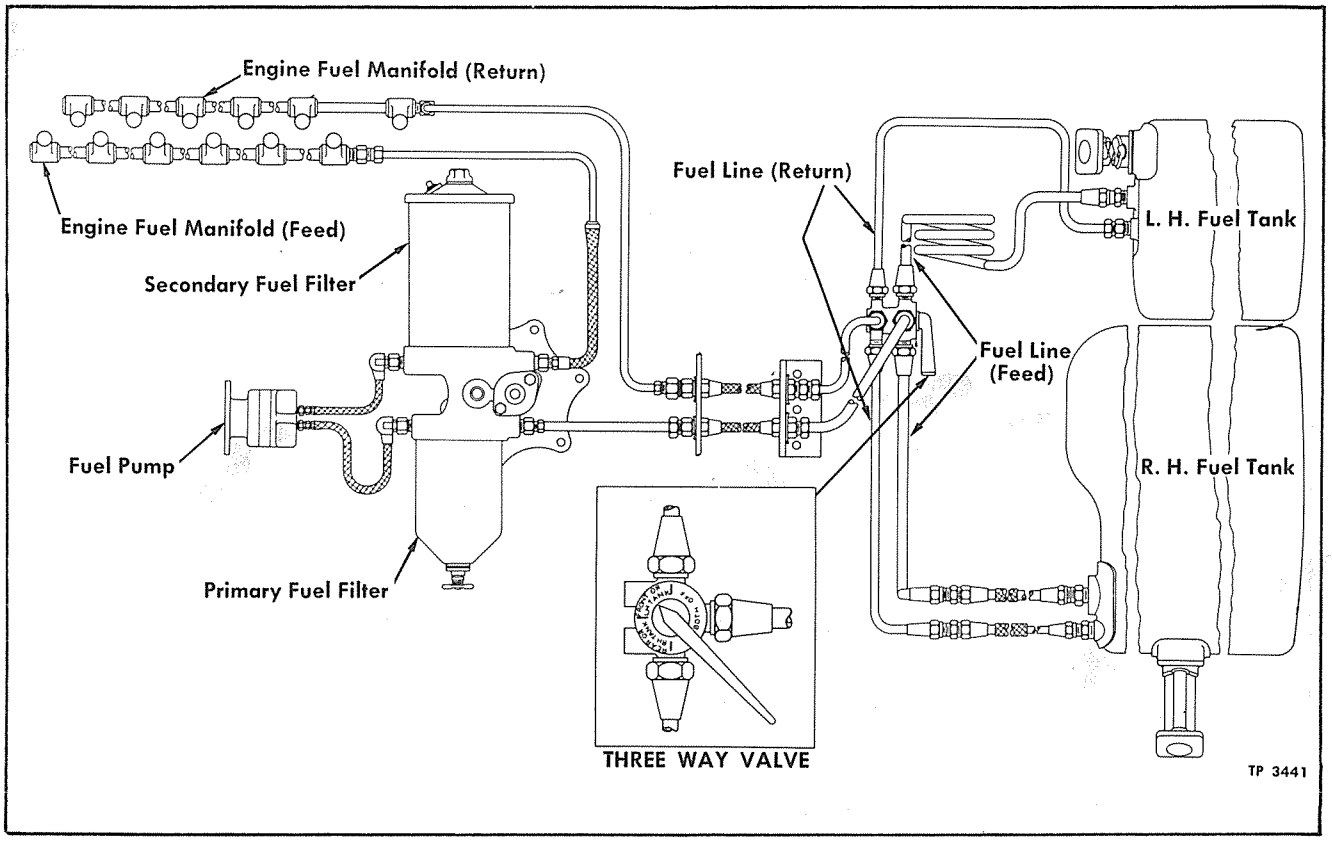


Figure 3—Fuel Tank and Lines

When consideration is given to the volume of air taken in by cleaner and amount of dirt present in average "road" air, importance of air cleaner maintenance may well be realized.

Conservative estimate of the amount of dirt taken into an air cleaner during a thousand mile operation may be 1/2 to 1-1/2 pounds. This quantity may vary more or less in different localities. In many localities, sand and fine abrasives are present in air.

When air cleaner is loaded and dirty, and is used past its saturation point, some of this fine abrasive will get past cleaner and considerably damage pistons, cylinder walls and bearings.

SERVICING AIR CLEANERS

Importance of keeping air cleaners in proper condition should be impressed on those responsible for mechanical upkeep of engine.

Air cleaners are used to keep road dust out of engine. This dust is loaded with minute particles of abrasive which, if permitted to enter engine, will cause rapid wear of cylinder walls, pistons and rings; with resultant loss of power and increase of oil and fuel consumption.

Unless air cleaners are cleaned periodically as service conditions require, they will not function properly, and in some instances, actually aggravate the condition which they are designed to prevent. If air cleaner is allowed to become clogged with dirt, and left in that condition, flow of air to blower will be restricted, thus causing increased fuel consumption, engine heating up, crankcase dilution, and otherwise affecting performance of engine.

For those reasons, air cleaner must be cleaned at regular intervals, at least every 1,000 miles, or more often if conditions warrant. Under adverse conditions or extensive operation on dusty or sandy roads, units should be cleaned every day or at least every 200 miles.

Air cleaners on vehicles operating in dust storm areas should be cleaned immediately after such storms occur.

CLEANING AIR CLEANER

Oil bath air cleaner must be cleaned in the following manner:

1. Loosen the two retaining clamps (one on each side) that retain the oil sump assembly to air cleaner outer shell. Remove sump.
2. Remove filter element from inner shell.
3. Clean filter element by plunging in clean

FUEL SYSTEM

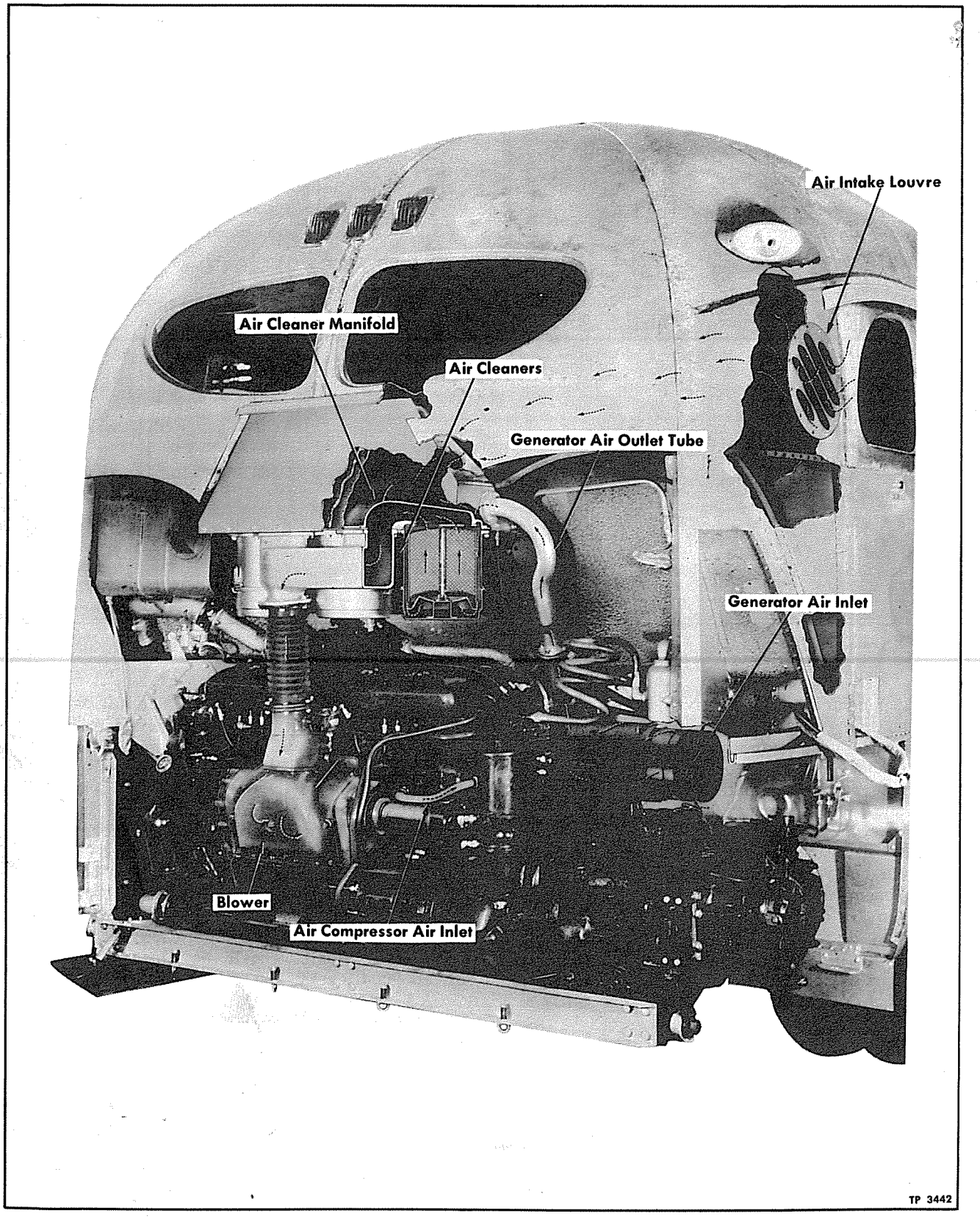


Figure 4—Air Intake System

gasoline or other suitable cleaning fluid until entirely clean.

4. Allow element to dry. DO NOT BLOW DRY WITH COMPRESSED AIR.

5. Clean out oil sump thoroughly then fill it to proper level with clean engine oil as shown in Lubrication (Sec. 13 of this manual). In the event oil becomes congealed due to cold weather, flush and refill with a lighter oil.

6. Air passage between inner and outer cleaner shell may be cleaned by removing attaching screws at cleaner manifold.

7. Assemble parts to cleaner by placing filter element in position in inner cleaner shell, then sump with oil at proper level into position on outer cleaner shell.

Engage clamp securing sump to outer shell to complete assembly. NOTE: Seal between sump and outer cleaner shell must be in good condition to seal air tight.

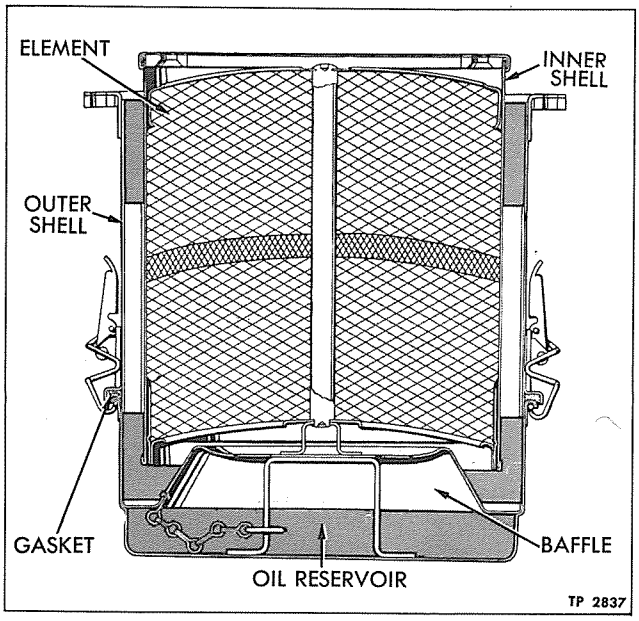


Figure 5—Sectional View of Air Cleaner

FUEL INJECTORS

For information on fuel injectors refer to Diesel Engine Maintenance Manual (Form X-4517).

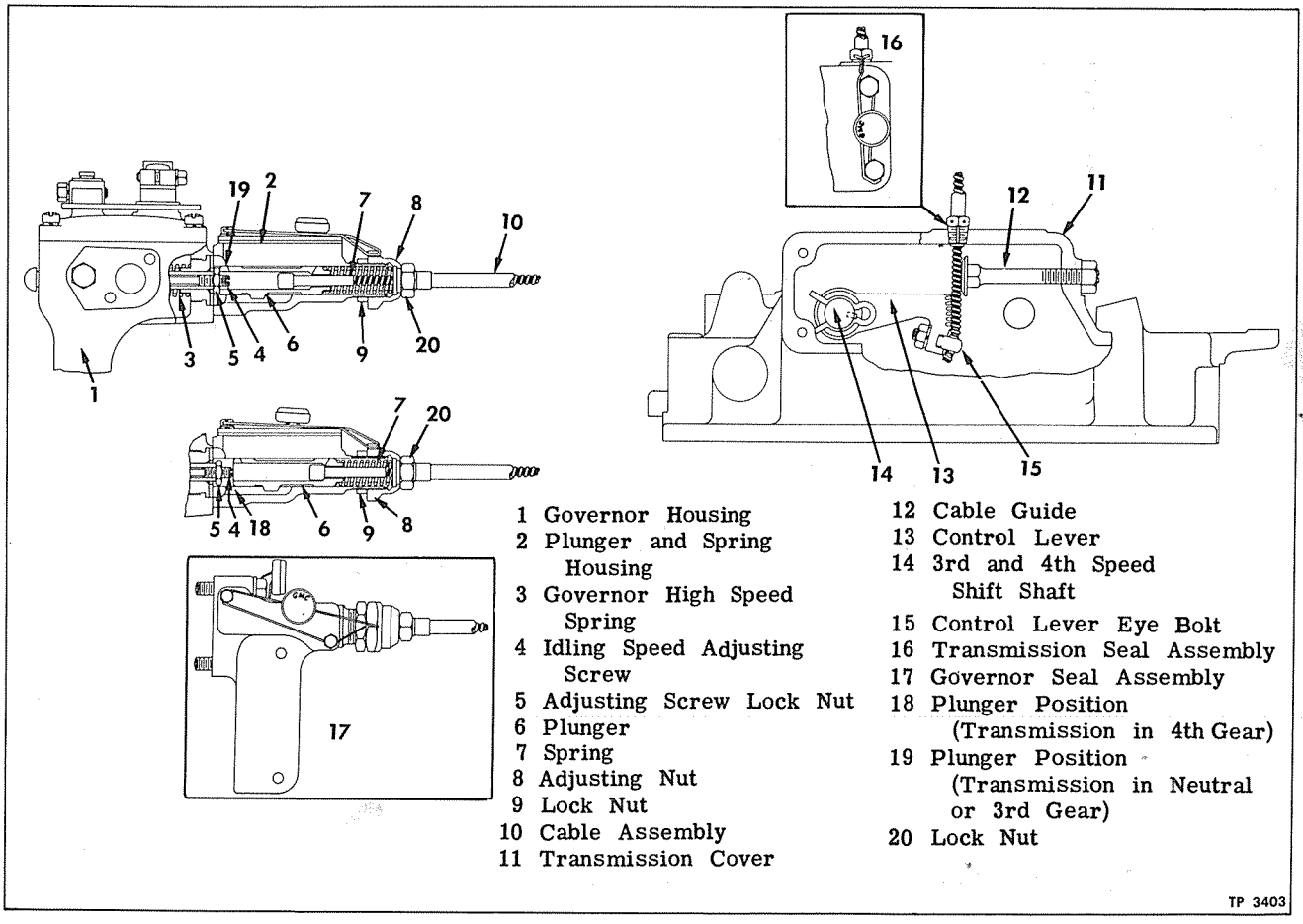


Figure 6—Duo-Speed Governor Control Adjustment

FUEL SYSTEM

FUEL PUMP

For information on fuel pump refer to Diesel Engine Maintenance Manual (Form X-4517).

GOVERNOR

For information on governor proper, refer to Diesel Engine Maintenance Manual (Form X-4517). However, vehicles covered by this manual are equipped with a Duo-Speed governor control which works in conjunction with governor proper. For description and adjustment of Duo-Speed governor control see following paragraph. Refer to "Specifications" at end of this section for maximum allowable engine rpm.

DUO-SPEED GOVERNOR CONTROL

Duo-speed governor control provides two stages of engine governed speed depending upon transmission gear selected. With this arrangement, increased engine speed is provided when vehicle is being operated in lower transmission gears where full power may be required. Refer to "Specifications" at end of this section for engine governed speeds.

Duo-speed governor control consists essentially of a flexible control cable connecting transmission shifting mechanism with Duo-speed governor plunger and spring as shown in figure 6.

When vehicle is operated in 1st, 2nd, or 3rd gear, Duo-speed governor spring (fig. 6) supplements high speed spring in governor proper, thereby permitting increased engine speed. As transmission is shifted into 4th gear, control cable moves plunger outward overruling action of the spring which allows governor to operate in regular manner.

ADJUSTMENT

Two adjustments are provided on Duo-speed governor control and may be accomplished as follows:

CONTROL CABLE ADJUSTMENT

In the event cable has been disconnected from transmission lever it may be readjusted in following manner:

1. With transmission in neutral, push control cable into conduit until cable end seats in plunger (do not compress spring), then pull cable out 3/8 inch and secure to transmission lever with eye bolt.
2. Install covers at transmission and Duo-speed adapter, then seal as shown in figure 6.

PLUNGER AND SPRING ADJUSTMENT (Fig. 6)

1. With transmission in neutral, screw adjusting nut "8" in or out as necessary to obtain engine speed of 2100 rpm - no load.
2. With transmission in 4th gear, accelerate engine to full throttle and check to make certain there is clearance between Duo-speed governor plunger and engine governor idling adjusting screw lock nut "5".
3. Tighten lock nuts "9" and "20" then install adapter cover and seal as shown.

SPECIFICATIONS

FUEL FILTER	
Primary (Lower)	
Make	AC
Type	T2
Secondary (Upper)	
Make	AC
Type	T2
AIR CLEANERS	
Make	AC
Type	Oil Bath
FUEL TANK	
Capacity (Gals.)	
Front	Approx. 83.5
Rear	39.5
GOVERNOR	
Maximum Allowable Engine RPM (No Load)	
1st, 2nd, and 3rd Gear	2100
4th Gear	1840

Lubrication

Contents of This Section

Related Subjects in Other Sections

Refer to All Sections in Manual for Design and Maintenance Information.

13

It is essential that care be exercised in the purchase and application of lubricants.

The application of the right lubricant in the right place and at the right time will greatly reduce the actual cost of transportation delivered.

THE RIGHT LUBRICANT

In your selection of the proper brand of oil it is desirable to consider the reputation of the refiner or marketer. He is responsible for the quality of this product and his reputation is the vehicle owner's best indication of quality.

THE RIGHT PLACE

Lubrication fittings or accessible lubrication points have been incorporated on all mechanical units of the vehicle, where lubrication is needed.

THE RIGHT TIME

Intervals at which various points on the chassis should receive attention are indicated on lubrication chart. Intervals are based upon actual experience and tests, as well as careful consideration of design and purpose of parts to be lubricated.

HOW TO USE THIS LUBRICATION SECTION

Select the lubrication chart applying to the vehicle to be serviced. This chart will locate the lubrication points, indicate the type (or symbol) of lubricant, give the recommended mileage intervals, and refer to the correct instruction note for each item. Instruction notes should be read and followed carefully when applying lubricant.

LUBRICATION

LUBRICATION NOTES

These notes, which correspond to numbers placed opposite the (right hand column) lubrication items on lubrication charts, include explanation of lubrication symbols, special lubrication instructions and references to detailed instructions in other sections of this manual. Use these notes in conjunction with the lubrication chart.

NOTE NO. 1 ENGINE OIL

(See Symbol E on Chart)

TYPES OF OIL

Crankcase oils in service, unless protected against oxidation, may form sludge and varnish and under some conditions corrosive acids.

To minimize the formation of these harmful decomposition products and to supply the type of oil best suited for the different operating conditions, the oil industry markets several types of crankcase oils. These types are defined by the General Committee, Division of Marketing of the American Petroleum Institute as follows:

"REGULAR MOTOR OIL, this term shall be used to designate a straight mineral oil. Oils of this type are generally suitable for use in internal combustion engines under moderate operating conditions."

"PREMIUM MOTOR OIL, this term shall be used to designate an oil having proved oxidation stability and bearing corrosion preventive properties. Oils of this type are generally suitable for use in internal combustion engines where operating conditions are such that regular oils do not give satisfactory service."

"HEAVY DUTY MOTOR OIL, this term shall designate an oil having oxidation stability, bearing corrosion preventive properties, and detergent-dispersant characteristics. Oils of this type are generally suitable for use in both High Speed Diesel and Gasoline Engines under heavy duty service conditions."

RECOMMENDED TYPE OF OIL

In heavy duty commercial service the crankcase oil usually operates at a much higher temperature than in light duty service and consequently is more subject to deterioration. Varnish on the pistons, valve stems and tappets causes sluggish operation of the engine. Sludge will eventually clog the oil pump screen, oil passages and oil control rings.

The Regular or straight mineral motor oils, are generally used under normal driving conditions in some light commercial vehicles under very light service conditions and passenger car engines. However, this type of oil is not recommended for Diesel engines used in vehicles covered by this manual.

The Premium motor oils can be used in gasoline engines in commercial service where operating conditions are normal or average.

The Heavy Duty motor oils are recommended for use in all heavy duty commercial service gasoline engines and must be used in Diesel engines covered by this manual. The heavy duty motor oils contain detergent-dispersant compounds which tend to hold in suspension the foreign contaminants which are then drained with the oil at oil change periods.

S.A.E. VISCOSITY NUMBERS

The S.A.E. viscosity numbers constitute a classification of lubricants in terms of viscosity or fluidity, but with no reference to any other characteristics or properties.

The S.A.E. viscosity numbers have been adopted by practically all oil companies, and no difficulty should be experienced in obtaining the proper viscosity grade in the different types of engine oils to meet seasonal requirements.

Successful operation of Diesel engine requires the careful selection of a Heavy Duty detergent-dispersant type lubricating oil. The oil must be the Heavy Duty type which has proved oxidation stability, bearing corrosion preventive properties and detergent-dispersant characteristics. Heavy Duty oils pick up and suspend fine particles of undesirable matter, thereby preventing their formation on engine internal surfaces. These contaminants are then drained off at time of oil change.

Use S.A.E. 30 engine oil for all normal operating conditions except; when temperatures consistently below +20°F. are encountered. Where prolonged engine exposure to temperatures below freezing is unavoidable use of 20W between +20°F. and 0°F. or 10W below 0°F. is suggested to facilitate cold starting.

Check oil level daily; keep to "full" mark

on dip stick. When oil filter element is renewed, oil strainer cleaned, or oil changed, engine should be run after filling and oil level rechecked.

DRAINING

The frequency with which crankcase oil must be changed depends upon the type and quality of oil used, the type or severity of operation, and the condition of the engine. It is therefore impossible to make a general recommendation concerning mileage intervals between oil changes. The oil should be changed often enough to keep it nonabrasive and noncorrosive. Oil changing is closely related to filter element and air cleaner element cleaning and changing, the frequency of which also depends upon the condition of operation mentioned above.

Laboratory tests of oil drained from the engine, conducted by the oil supplier of by another suitable laboratory should be helpful in determining the greatest advisable interval between oil and filter element changes for your operation. Whether such tests are conducted or not, your oil supplier should be able to recommend suitable oil change periods for his oil in your operation.

RESERVE OIL TANK

Reserve oil tank serves as a reservoir of engine oil for replenishing oil supply in engine crankcase. Refer to Operation (Sec. O of this manual) for complete instructions.

CHANGING TYPE OF OIL

In some instances operators may be using "Regular" or "Premium" engine oils instead of the recommended "Heavy Duty" oil. If this is the case the following procedure is recommended when "Heavy Duty" type engine oil is first used. The engine should not be run for more than 24 hours on the new oil, then drained and crankcase refilled. This prevents any dangerous obstruction of oil pump intake screen or oil strainer by any previously formed oxidation deposits which might be loosened by purging action of oil. The second crankcase filling should be drained out after running 40 hours, at which time oil filter element should be renewed. Following these two oil changes the previously recommended or newly established oil drain periods can be followed.

OIL STRAINER

Whenever engine oil is drained the oil strainer element and strainer should be cleaned. Wash inner and outer surfaces of element and strainer in suitable cleaning solvent. A fine bristle (not wire) brush is satisfactory for cleaning.

OIL FILTER

Whenever engine oil is drained the oil filter element should be changed and filter cleaned. Filter element changing and cleaning filter should remove all accumulations of sludge and harmful abrasives that might otherwise contaminate the clean oil.

AIR CLEANERS (BLOWER)

Keep oil level in air cleaners to "full" mark. At intervals recommended on lubrication chart, or more often if conditions warrant, clean and refill. Use the same grade and type of oil as used in crankcase.

GENERATOR AIR CLEANER (Oil Wetted Type)

At intervals recommended on lubrication chart, or more often if conditions warrant, remove and clean in cleaning solvent. Dry thoroughly. Use light grade oil to wet mesh element, then allow excess oil to drain off before installing.

STARTING MOTOR

At intervals recommended on lubrication chart apply S.A.E. 20 engine oil at three oilers.

DOOR HINGES

At intervals recommended on lubrication chart, door hinges and operating mechanism should be lubricated with light engine oil. Operate door after lubricating to permit oil reaching friction points.

SHUTTER LINKAGE

As recommended on lubrication chart, radiator shutter linkage should be lubricated only when linkage is new.

LINKAGE

At all linkage joints and clevis pins apply oil with brush, spray or hand oil can.

ROLLERS AND WEDGE RODS (Spare Tire Compartment)

At intervals recommended on lubrication chart apply engine oil to rollers and wedge rods. Refer to Body (Sec. 3B of this manual) for location and accessibility.

LUBRICATION

NOTE NO. 2 ENGINE OIL – SPECIAL

(See Symbol ES on Chart)

The type of oil, indicated by symbol "ES," must be carefully selected, as ordinary engine and gear oils are not satisfactory. Oil must be of good quality S.A.E. 50 such as aviation grade engine oil. NOTE: Where aviation type of engine oil is not available, S.A.E. 50 Heavy Duty engine oil having detergent-dispersant properties, oxidation resistance, and anti-foam characteristics may be used as optional lubricant.

TRANSMISSION

Keep lubricant to "full" mark on dip stick. Drain and refill at least every 15,000 miles. Drain only while transmission is warm. NOTE: Do not use extreme pressure or hypoid lubricants in transmission.

STEERING BEVEL GEAR HOUSING

Use pressure gun on fitting and apply until grease appears at overflow tube.

STEERING GEAR HOUSING

Remove filler plug. Use pump gun and apply until lubricant is up to level of filler plug. Install filler plug.

NOTE NO. 3 GEAR OIL

(See Symbol G on Chart)

Use gear oil of best quality. Oils undergo chemical changes at high temperature with thickening as the result. This instability, which should not be confused with viscosity (body), may produce oil that is too thick for adequate lubrication. Gear oils most resistant to thickening are filtered steam refined cylinder stock or bright stocks.

REAR AXLE

Keep lubricant to level of filler plug. Drain and refill at least every 15,000 miles. Drain while axle is warm, preferably immediately after operation. Use S.A.E. 90 gear oil for winter and S.A.E. 140 for summer.

PROPELLER SHAFT UNIVERSAL JOINT

Use pressure gun at fitting and apply until lubricant is visible at relief valve. Use S.A.E. 140 gear oil for summer, and S.A.E. 90 during winter.

STEERING SHAFT UNIVERSAL JOINTS

Universal joints are not provided with relief valves. Lubricant until lubricant appears around journals.

NOTE NO. 4 CHASSIS LUBRICANT

(See Symbol C on Chart)

Chassis lubricant should be used at all points indicated by symbol "C" on lubrication chart.

All pressure gun lubrication points must be clean before applying gun. Replace all broken or missing fittings. Apply sufficient lubricant to thoroughly lubricate entire bushing or bearing.

Chassis lubricant should be a high grade calcium or aluminum soap pressure gun lubricant. Sodium soap grease may be used as chassis lubricant, but more frequent application may be required during wet weather.

NOTE NO. 5 15% SODIUM SOAP GREASE

(See Symbol S2 on Chart)

A short fibre non-fluid sodium soap (approximately 15%) grease having a high melting point.

GENERATOR

Turn cups down at intervals specified. Refill cups when empty.

CLUTCH RELEASE BEARING

Turn handle down one turn, or until cup begins to turn hard indicating that lubricant is under pressure. Refill cup when empty.

WHEEL BEARINGS

Remove wheel bearings as instructed in Hubs and Bearings (Sec. 19A of this manual). Wash bearings, hub and spindle in cleaning solvent. Inspect hub and bearings. Coat spindle and inside of hub with thin coat (approximately 1/8" thick) of grease to prevent rusting. Lubricate bearings thoroughly, using a lubricator or by hand pack method. Be sure lubricant reaches into all spaces of the bearing. DO NOT FILL HUB. Reinstall and adjust bearings as directed in "Hubs and Bearings" (Sec. 19A of this manual).

CLUTCH PILOT BEARING

Rotate flywheel until plug appears at opening in flywheel. Remove plug and install temporary fitting. Use hand pressure gun to apply lubricant sparingly. Remove fitting and replace plug.

BRAKE SHOE ANCHOR PINS

Remove plugs, install temporary fittings. Use pressure gun, apply lubricant sparingly. Remove temporary fittings and replace plugs.

FAN PULLEY BEARING

At intervals indicated on lubrication chart, apply specified lubricant through fitting until lubricant appears at overflow tube.

FAN IDLER PULLEY

At intervals indicated on lubrication chart, apply specified lubricant through fitting until lubricant appears at relief hole in end of shaft.

STEERING COLUMN UPPER BEARING

Bearing should be lubricated at time of assembly with recommended lubricant. Refer to "Steering Gear" (Sec. 16 of this manual) for procedure.

NOTE NO. 6 PETROLEUM JELLY

(See Symbol S3 on Chart)

BATTERY TERMINALS

Keep battery cables clean. At regular periods, remove cables, clean terminals on cables and battery. Apply petroleum jelly after tightening terminals to prevent corrosion.

NOTE NO. 7 GRAPHITE GREASE

(See Symbol S5 on Chart)

A high temperature grease containing graphite or other inert materials.

CLUTCH SHAFT SPLINES

At time of assembly apply lubricant to clutch shaft splines and hub. Do not use an excessive amount of lubricant as it may reach the facings.

BRAKE CAM AND SHOE ROLLERS

At intervals specified on lubrication chart or whenever accessible apply lubricant to brake camshaft cams and shoe rollers. Application of lubricant to these points is important if brake efficiency is to be maintained.

LUBRICATION

NOTE NO. 8 SHOCK ABSORBER FLUID

(See Symbol S6 on Chart)

A special shock absorber fluid should be used whenever additional fluid is necessary.

SHOCK ABSORBERS

At specified intervals level of fluid in shock absorbers should be checked. Disconnect link at shock absorber arm as directed in "Springs" (Sec. 15 of this manual). Remove plug from shock absorber body. Move shock absorber arm up and down slowly as fluid is added. Continue arm movement and adding operations until fluid level remains at plug opening level. Replace plug and reconnect link.

NOTE NO. 9 DENATURED ALCOHOL

(See Symbol S10 on Chart)

Use alcohol anti-freeze solutions as directed in "Cooling System" (Sec. 6B of this manual).

SHUTTER THERMOSTAT

Disconnect line at thermostat and inject 1 ounce denatured alcohol at intervals indicated on lubrication chart. Refer to "Radiator, Shutter, Thermostat" (Sec. 6B of this manual) for complete instructions.

NOTE NO. 10 HYDRAULIC BRAKE FLUID

(See Symbol S12 on Chart)

Fluid recommended for this application should be Delco-Super #10 or Wagner Lockheed #21-11.

SWAY-BAR BUSHINGS AND SHOCK ABSORBER LINKS

At intervals recommended on lubrication chart, sway-bar rubber bushings and shock absorber links should be sprayed or brushed with recommended fluid which serves as a rubber preservant.

NOTE NO. 11 AIR FILTER FLUID

(See Symbol S13 on Chart)

Recommended fluid for this application is a special air filter fluid which is compounded especially for use in this unit.

SHUTTER AIR FILTER

Remove plug at top of filter reservoir. Inject 1 ounce of recommended fluid at specified intervals. Larger quantities or more frequent fillings are not recommended as system may be overloaded. Replace plug.

Weekly, during summer months, or daily during winter open the pet cock at bottom of filter to drain accumulated moisture. Drain under pressure.

Spring Suspension

Contents of This Section

Related Subjects in Other Sections

Vehicle chassis and body are supported by semi-elliptic type springs. Front springs are mounted on I-beam of front axles (fig. 1), while rear springs are suspended from rear axle housing (fig. 2). Each front spring assembly is attached to front axle with two U-bolts. Rear springs are bolted to rear axle housing with four straight bolts. Front ends of front springs are held in stationary brackets; rear ends are shackled to allow longitudinal movement (fig. 1). Rear springs are shackled at forward ends, while rear ends are held in stationary brackets (fig. 2).

Spring leaves are held together and in alignment by center bolts and by four rebound clips. Each clip consists of a "U" shaped strap with a bolt passing through upper ends of clip and over top spring leaf. Bottom of "U" is riveted to shortest leaf which clip retains.

To prevent excessive damage in the event of accidental spring breakage at spring eye, front springs are equipped with a safety bar at pivoted end. Rear springs are equipped with safety straps at pivoted end for the same purpose.

GENERAL SPRING MAINTENANCE

LUBRICATION

On front springs, lubrication fitting is installed in a drilled opening in front axle, which leads to center bolt, as shown in figure 1. On rear springs, lubrication fitting is installed in an adapter threaded onto center bolt (fig. 2). Center bolts are grooved to permit passage of lubricant to center portion of spring leaves.

WARNING: Excessive lubrication of spring leaves tends to make springs too flexible, which will decrease life of springs, and should be avoided. Refer to Lubrication (Sec. 13, of this manual) for lubrication directions.

Threaded type shackle pins are used on both front and rear springs. Pins are drilled and equipped with pressure gun lubrication fittings, (figs. 1 and 2), to provide facilities for lubricating spring eye bushings and frame bushings. NOTE: Upper shackle pin bushing, on left rear spring, is lubricated through tube mounted in shackle bracket. Shackle pins should be lubricated periodically as directed in Lubrication (Sec. 13, of this manual).

Do not lubricate shock absorber linkage or sway bar linkage as links are rubber bushed and lubricant has a deleterious effect on rubber.

TIGHTENING

At regular intervals, check rebound clip bolts and tighten sufficiently to hold spring leaves in alignment without restricting free movement of leaves. Loose rebound clip bolts may permit spring leaves to shift, shearing head of spring center bolt and causing misalignment of axles.

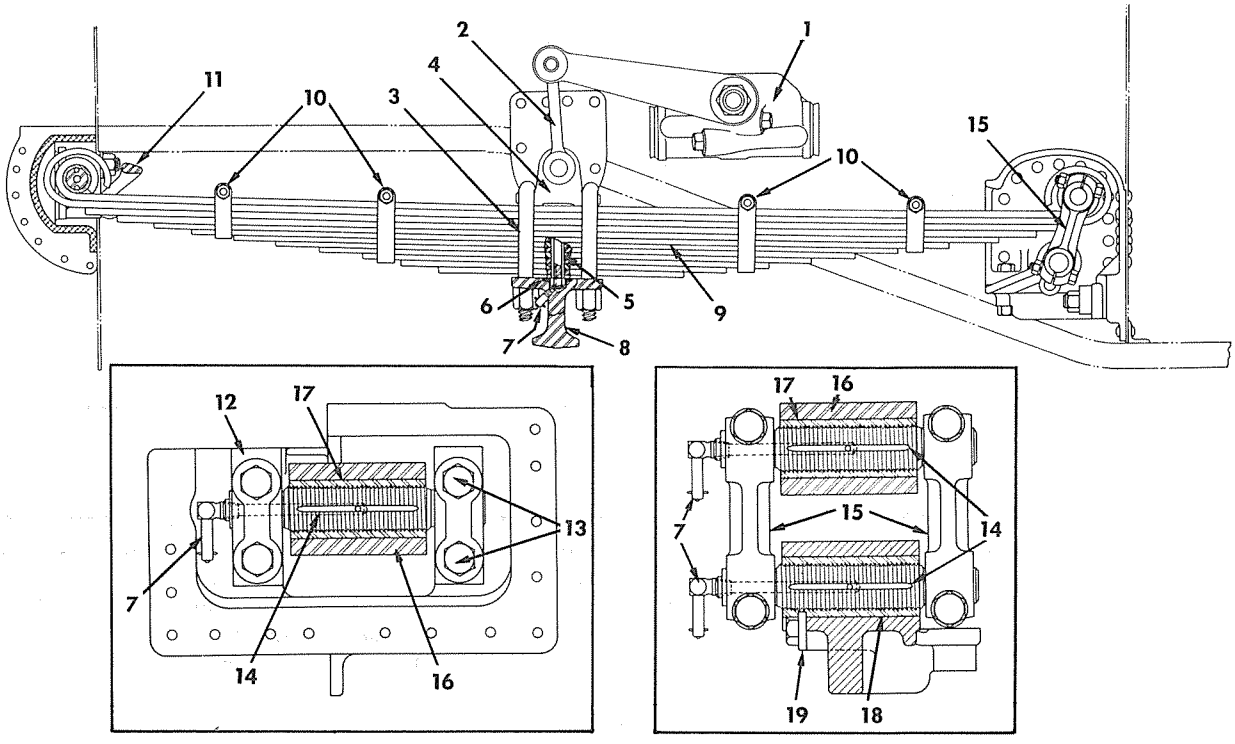
IT IS IMPERATIVE THAT CENTER BOLTS BE KEPT TIGHT. When center bolts are loose, spring leaves are not efficiently lubricated. In order to tighten front spring center bolt, it is necessary to detach front spring from front axle. Rear spring center bolt nut may be tightened after lubrication fitting and adapter have been removed.

Rear spring pins should be inspected periodically and drawn up until shackle plate rests snugly against shoulder of shackle pin; so that shackle plate will not oscillate on neck of shackle pin.

Spring U-bolts should be checked for tightness regularly; and, if loose, should be tightened with spring under normal load. This is done to remove camber from spring since sufficient force usually cannot be applied to U-bolt nuts to compress an unloaded spring.

Spring anchor bolts and front spring shackle clamp bolts should be kept tight to eliminate excessive shackle pin wear.

SPRING SUSPENSION



1 Shock Absorber
2 Shock Absorber Link
3 U-Bolts
4 U-Bolt Spacer
5 Center Bolt
6 Lubrication Seal Washer
7 Lubrication Fitting
8 Axle Center
9 Spring Assembly
10 Rebound Clips
11 Safety Bar
12 Anchor Block
13 Anchor Bolts
14 Shackle Pin
15 Shackle
16 Spring Eye
17 Spring Eye Bushing
18 Frame Bushing
19 Frame Bushing Lock Plate

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Figure 1—Front Spring Mounting and Shock Absorber Installation

SPRING REPLACEMENT

If spring assemblies have taken a "set," that is, lost their resilience or elastic properties, it is recommended that such springs be replaced with new springs rather than attempting to restore camber by heating, bending, and tempering.

SPRING REMOVAL

After shock absorber link (front springs) and sway bar link (rear springs) have been disconnected at axle, front or rear spring assemblies may be removed in the following manner:

1. Block wheels of vehicle to prevent rolling then jack up both sides of end of vehicle, from which spring is to be removed until spring tension is relieved. Jacking up both sides of vehicle will help reduce torsional strain on shackle pins. Place block under end of axle and spring to be serviced.

2. Loosen spring assembly to axle mounting bolt nuts so they may be removed later without difficulty.

3. Remove nuts and lock washers from anchor bolts, drive bolts out of anchor blocks, then remove anchor blocks.

4. Remove all lubrication fittings from shackle pins, then remove nuts and lock washers from all rear spring shackle pins and remove shackle plates. Front spring shackles may be removed after shackle clamp bolts have been removed from shackles.

5. After placing support under spring assembly, to keep spring from dropping on floor, complete removal of spring assembly to axle mounting bolts; thereby disconnecting spring from axle and completing removal of spring. Remove and discard lubrication seal washer (6, fig. 1).

SPRING INSTALLATION

Spring center bolt is located forward of spring center on both front and rear spring assemblies, as shown in "Specifications" at end of this section.

In order to insure correct positioning of axles. it is imperative that spring assemblies be installed with longer portion of spring rearward of axle.

FRONT SPRINGS

1. Install new lubrication seal washer (6, fig. 1) in recess in axle center, position spring on I-beam of front axle correctly, place U-bolt spacer on spring, then install U-bolts, tightening nuts securely.
2. Place shackles on rear shackle pins, making sure milled slots in pins are lined up with clamp bolt holes in shackles, then install shackle clamp bolts, lock washers, and nuts.
3. Position anchor blocks on front shackle pin, making sure milled slots in pin are lined up with anchor bolt holes in anchor block. Place anchor bolts in anchor blocks, position safety bar on anchor bolts, then install lock washers and nuts on anchor bolts.
4. Connect shock absorber link to U-bolt spacer, tighten link stud nut securely then back off nut just enough to install new cotter pin.
5. Install lubrication fittings in inner ends of all shackle pins and in opening in front axle.
6. Tighten all nuts and bolts as directed, previously, under "General Spring Maintenance" in this section.

REAR SPRINGS

1. Position spring under rear axle housing, correctly, then install spring retainer assembly and mounting bolts, tightening nuts securely.
2, Position anchor blocks on rear shackle pin, making sure milled slots in pin line up with anchor bolt holes in anchor blocks, then install anchor bolts, lock washers, and nuts.
3. Place shackle plates on front shackle pins and secure with new lock washers and nuts.
4. Connect sway bar link to spring retainer bracket, tighten link stud nut securely, then back off nut just enough to install new cotter pin.
5. Install lubrication fittings in inner ends of all shackle pins and in adapter on end of center bolt.
6. Tighten all nuts and bolts as directed, previously, under "General Spring Maintenance" in this section.

SPRING OVERHAUL

If it becomes necessary to replace a broken spring leaf, broken rebound clip, or a worn spring eye bushing; spring must be removed from vehicle and disassembled.

DISASSEMBLY

1. Clamp spring leaves firmly together, using one C-clamp on each side of center bolt, then remove rebound clip nuts, bolts and spacers. If a rebound clip is badly damaged, cut off rivet head to remove clip from spring leaf.
2. Remove lubrication fittings from ends of shackle pins, then remove center bolt from spring. Remove C clamps, releasing spring tension slowly to avoid possible injury.
3. Place wrench on hex-head end of shackle pins and back threaded pins out of spring eye bushings.
4. Press spring eye bushings out of spring eyes; use arbor press and suitable bushing removing tools.
5. Bushings are used in frame at rear shackle end of springs only. To remove frame bushing, first remove lock bolt and lock plate; then drive bushing out of frame. NOTE: Rear spring frame bushing lock bolts are safety-wired to prevent accidental loosening.

CLEANING AND INSPECTION

1. Clean all rust and dirt from spring leaves, using a wire brush, then inspect leaves for cracks or breaks. Replace leaves that are cracked or broken.
2. Clean out oil passages in shackle pins and wash old grease and dirt from lubrication fittings. Be sure all lubricant passages are clean.
3. Check spring eye bushings and shackle pins for excessive wear and replace if necessary. Refer to "Specifications" at end of this section.
4. Examine shackle plates, shackles, anchor bolts, center bolt, rebound clips, rebound clip bolts, anchor bolts, and U-bolts for evidence of wear or failure. Replace any parts that are unfit for further service.

SPRING ASSEMBLY

1. Install spring eye bushings, use arbor press and suitable bushing driver. Make sure bushing is aligned with hole in spring eye before attempting to press bushing into place. NOTE: Ends of bushings should be flush with sides of spring eyes as shown in figures 1 and 2.
2. Apply a coating of lubricant specified in Lubrication (Sec.13, of this manual) to spring leaves, stack spring leaves in correct order, then align the center bolt hole. Place assembly in arbor press, or use two C-clamps to compress leaves, then install center bolt. Center bolt should be installed as shown in figures 1 and 2.
3. Install rebound clips. If any rebound clips were removed from spring leaves, these should be riveted to leaves using rivets of same size as those removed. When bottoms of rebound clips are secured to spring leaves, install rebound clip

SPRING SUSPENSION

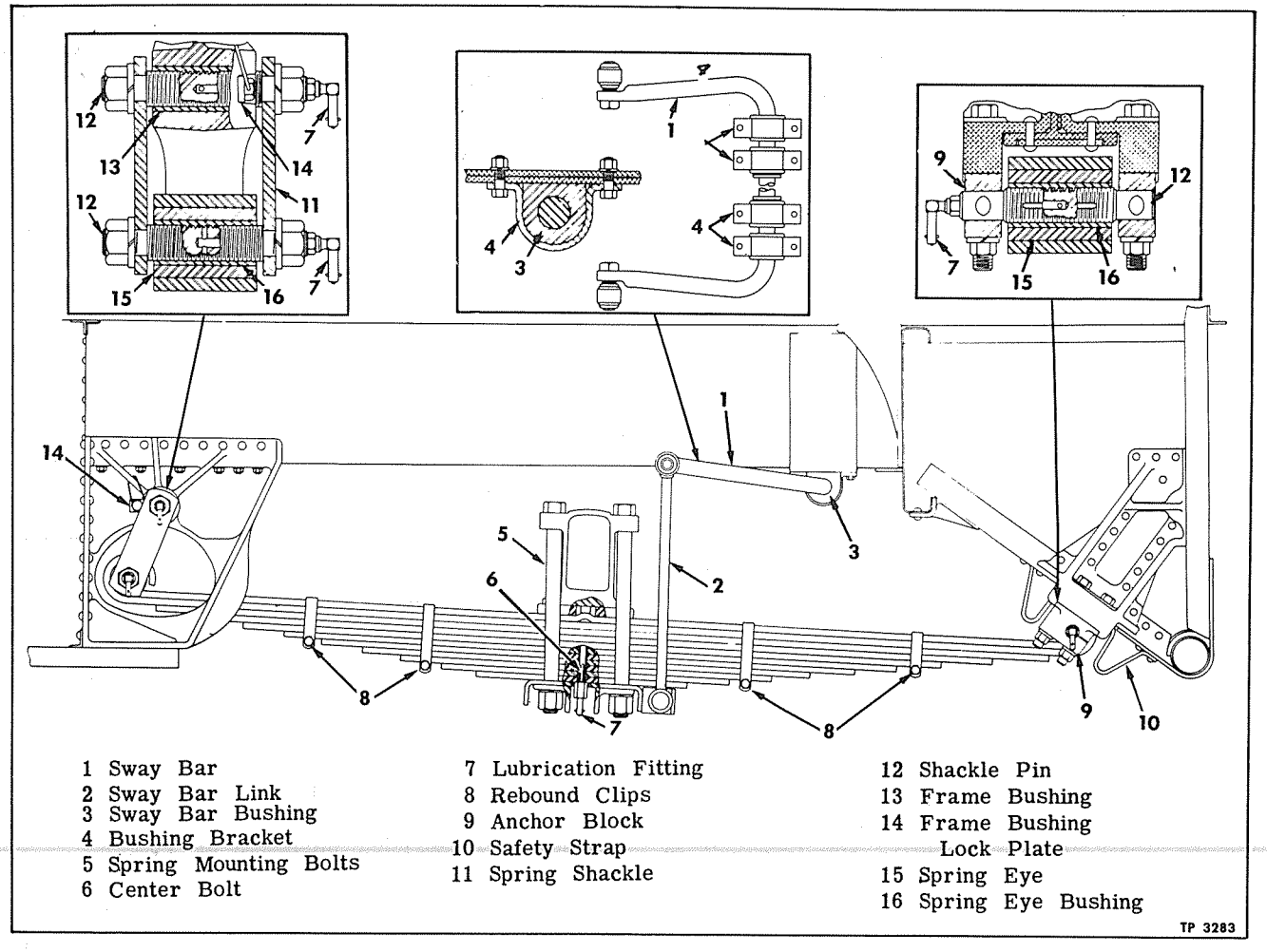


Figure 2—Rear Spring Mounting and Sway Bar Installation

bolts, spacers, and nuts. Tighten nuts just enough to hold leaves in alignment, without restricting free movement of leaves.

4. Dip shackle pins in chassis lubricant then thread pins into spring eye bushings and frame bushing with holes for lubrication fittings positioned as shown in figures 1 and 2. NOTE: Ends of shackle pins should protrude an equal distance on both ends of spring eye bushings.

5. Install frame bushing. Align bushing with hole in frame bracket, with the lock notch in bushing at proper angle, then drive in place using suitable bushing driver. Install and tighten lock plate, lock plate bolt, new lock washer, and nut.

SWAY BARS

To minimize road shocks and swaying of rear end of vehicle, rubber mounted sway bars have been installed on rear of vehicle. Transverse section of sway bar is mounted in four rubber bushings and is attached to coach side rail support brackets with four U-shaped clips as shown in figure 2. Arms of sway bar extend toward front of vehicle and are connected to spring retainer plate assembly with rubber bushed link arms.

Unsatisfactory sway bar action and noise may be caused by worn joints in link between spring retainer plate and sway bar arms. To determine if and where worn condition exists, disconnect link and check for looseness in joint at both ends of link. Links are so constructed that, if joints are worn, new links must be installed.

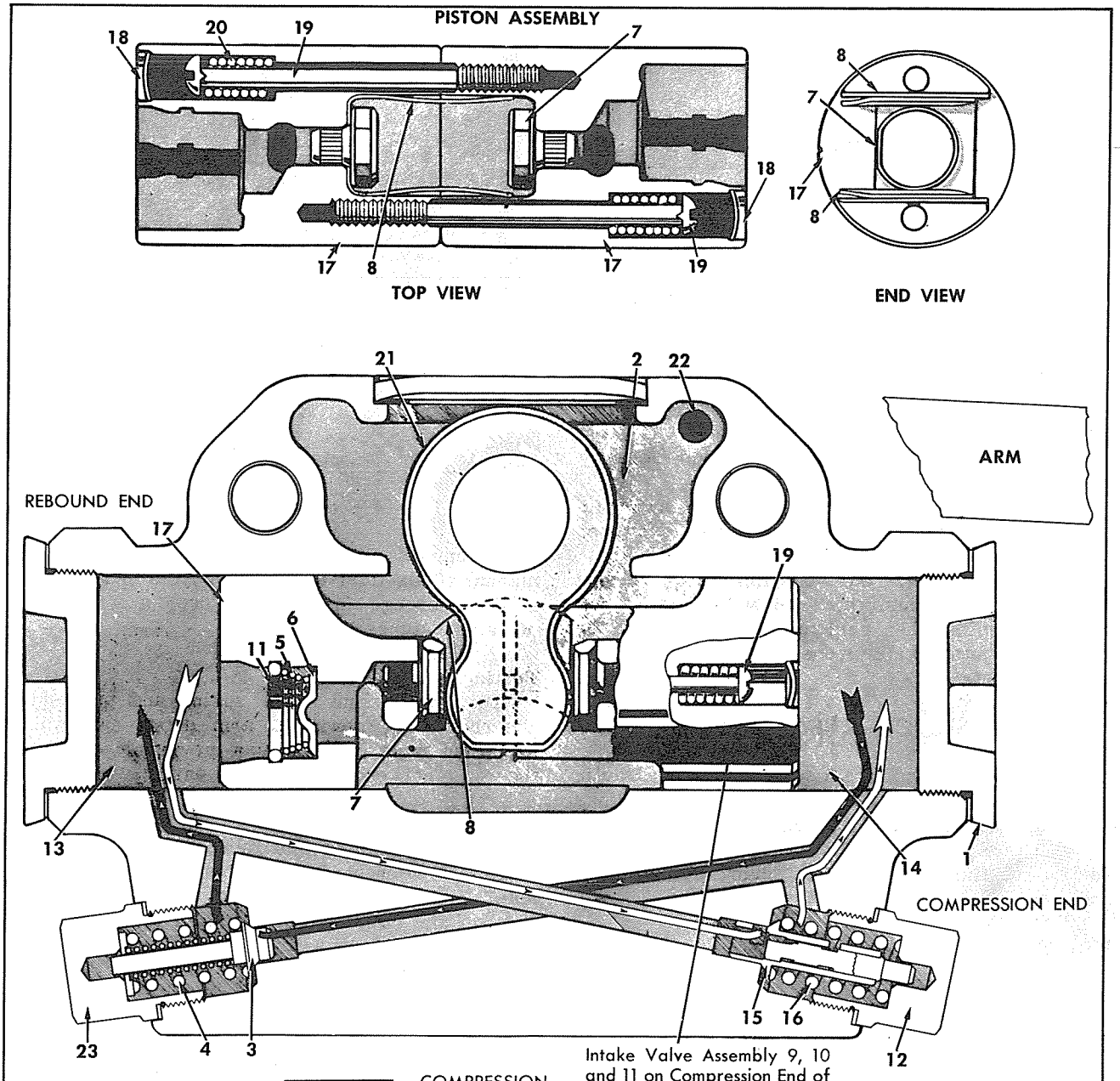
SUPPORT BUSHING REPLACEMENT

If it becomes necessary to replace rubber support bushings, proceed as follows:

1. Jack up rear of vehicle to relieve spring tension then disconnect sway bar links from spring retainer plate assembly.

2. Disconnect sway bar links from sway bar arms. Remove bolts attaching U-shaped clips and sway bar cross-member to frame side rail support brackets.

SPRING SUSPENSION



1 End Cap
2 Fluid Reservoir
3 Compression Valve
4 Compression Valve Spring
5 Intake Valve Spring—Rebound End
6 Intake Valve—Rebound End
7 Cam Button
8 Anti-Rotation Spring
9 Intake Valve—Compression End
10 Intake Valve Spring—Compression End
11 Valve Spring Retainer Clip
12 Rebound Valve Nut
13 Rebound End of Shock Absorber
14 Compression End of Shock Absorber
15 Rebound Valve
16 Rebound Valve Spring
17 Piston
18 Piston Screw Expansion Plug
19 Piston Screw
20 Piston Screw Spring
21 Cam
22 Fill Plug
23 Compression Valve Nut

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Figure 3—Shock Absorber Construction

SPRING SUSPENSION

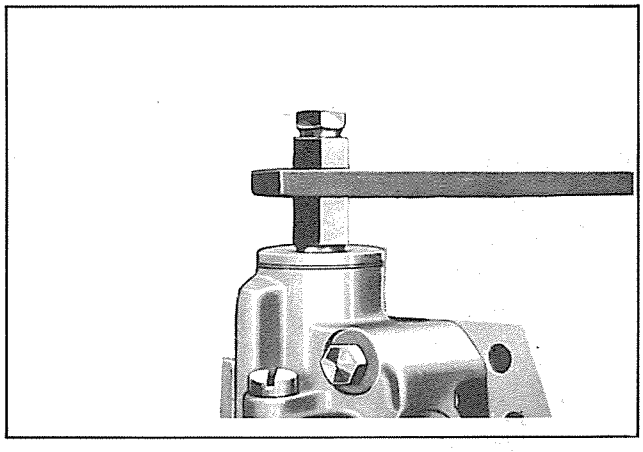


Figure 4—Removing Shock Absorber End Cap

3. Slip worn bushings off over ends of sway bar cross-member.

4. Coat new rubber bushings with hydraulic brake fluid then slide bushings into place over ends of sway bar cross-member.

5. Reinstall sway bar and linkage, reversing steps listed previously for removal. Always use new cotter pins when reinstalling linkage and be sure eye of sway bar is properly seated on tapered stud in joint.

SHOCK ABSORBERS

Shock absorbers are double acting hydraulic type, interconnecting frame and axle through links (fig. 1), and are used at front springs only.

Shock absorber sectional view, showing direction of fluid flow during spring compression and rebound, is shown in figure 3.

MAINTENANCE

Units should be inspected, links tightened and fluid level checked at regular intervals. Valves of proper spring strength and orifice size have been selected to give the best possible performance and should not be changed under ordinary conditions.

While units are constructed so as to permit overhauling in the field, this operation requires special tools and equipment. If facilities are not available to do this work, shock absorbers may be taken to any GMC Service Station for repair or complete overhaul. Shock absorbers should be overhauled, approximately every 50,000 miles. Before proceeding with any repair operation, be sure tires are properly inflated according to tire manufacturer's recommendations. Smooth operation is obtained only when spring shackles operate freely and tires are correctly inflated.

FLUID

When refilling units with fluid, use only fluid recommended in Lubrication (Sec. 13, of this manual. This fluid is non-corrosive and has only a slight change in viscosity over a wide range of temperatures.

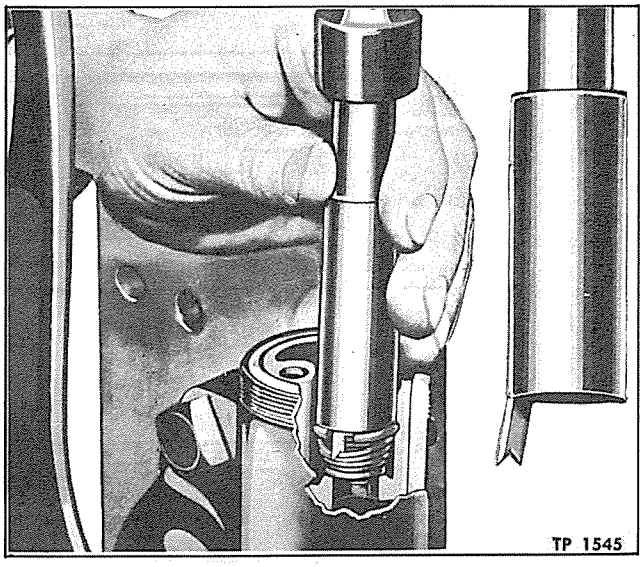


Figure 5—Installing Valve Spring Retainer

Testing

Disconnect link from spring and pull shock absorber arm down. If arm drops easily part way, then stops and continues moving down slowly, there is not enough fluid in unit.

Filling

Clean exterior of unit then remove filler plug. Fill with correct fluid to bottom of filler plug hole. Replace filler plug and move shock absorber arm up and down to work fluid into piston cylinder, then add enough fluid to fill reservoir. To provide necessary air space, allow fluid to escape down to lower edge of filler plug hole before replacing plug. If leaks are evident around end cap, valve plug, or filler plug, replace gaskets.

Packing washers on shock absorbers which have been operating with fluid below proper level, may become worn, causing leaks around shaft. Leaks of this nature require replacement of unit.

REPLACEMENT

Removal

While shock absorber can be removed with wheel in place, removal of wheel will make shock absorber more accessible. Disconnect link from shock absorber arm. Disconnect unit from frame side rail, and remove from vehicle.

Installation

Reverse removal procedures. When installation is complete, tighten all screws and nuts, then paint unit and fittings.

MAJOR OVERHAUL

If shock absorber body or arm is broken, arm is "frozen," absorber leaks at arm, or there is no resistance in unit when arm is moved and unit is full of fluid; then shock absorber should be overhauled.

DISASSEMBLY (Fig. 3)

1. Remove dirt, grease, and loose paint from exterior.
2. Remove unit from vehicle and place in vise, being careful to clamp vise so as not to cause a bind on pistons.
3. Remove filler plug, drain fluid completely; then remove end caps (with special tool No. J-767, on front shock absorbers).
4. Remove relief valve nuts (12 and 23), rebound valve (15), compression valve (3) and intake valves (6 and 9). To remove intake valves, first remove valve spring retainer clip with a screw driver; then lift valves out.
5. Remove plugs (18) over piston screws (19), then disassemble piston (17).
6. Wash all parts in kerosene then inspect for wear. Blow out valve orifices with compressed air until clean.
7. Check camshaft for wear in housing by moving shock absorber arm sideways. If shaft is "galled" or worn, replace complete shock absorber.

ASSEMBLY (Fig. 3)

1. Assemble piston. Try both sizes of piston in cylinder. Use size which allows some clearance otherwise binding and noise will result. Position piston and anti-rotation spring (8) as shown in figure 3.
2. Tighten piston screws firmly then back off one to one and a half turns to prevent binding between cam (21) and cam buttons (7), then install new plugs over piston screws.
3. Replace intake valves and valve spring retainer clips using tool No. J-896-A.
4. Replace rebound valve (15), valve nut (12), compression valve (3), and valve nut (23). Use new gaskets.
5. Install one end cap (using new gasket) then rotate unit and fill to capacity with fluid. While filling, move arm to expel air from fluid.
6. Install other end cap then fill unit as previously directed under "Fluid," in this section.

NOTE: Shock absorber body, arm, packing gland, camshaft, and cam are not replaceable due to special fixtures and presses required to assemble and disassemble these parts.

SHOCK ABSORBER LINKS

Links are used between shock absorber arm and axle as shown in figure 1. Unsatisfactory shock absorber action and noise may be caused by worn joints in links. To determine if and where worn condition exists, disconnect link and check for looseness in joints at both ends of link. If joints are worn, new links must be installed.

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily accomplish certain service operations. Names and addresses of vendors are listed, and any information regarding availability, price, etc., should be obtained directly from them.

Tool No.	Tool Name
J-767	Shock Absorber (Hexagon)End Cap Wrench
J-896-A	Shock Absorber Valve Installing Tool

Vendor	Address
Kent-Moore Organization	Detroit, Michigan

SPRING SUSPENSION

SPECIFICATIONS

FRONT SPRINGS

Leaves
- No. of Leaves ..... 12 or 13
- Thickness
  - 12 Leaf Spring ..... 2 @ 7/16"; 4 @ 3/8"; 5 @ 11/32"; 1 @ 5/16"; ..... 4 13/32"
  - 13 Leaf Spring ..... 1 @ 13/32"; 1 @ 3/8"; 11 @ 5/16"; ..... 4 7/32"
- Width ..... 4"
- Length (When Loaded)
  - Center to Center of Spring Eyes ..... 58 3/4"
  - Center of Front Eye to Seat Center ..... 28 1/4"
  - Center of Rear Eye to Seat Center ..... 30 1/2"
- Rebound Clips 4

REAR SPRINGS

Leaves
- No. of Leaves 13
- Thickness
  - Either ..... 3 @ 17/32"; 9 @ 15/32"; 1 @ 7/16"; ..... 6 1/4"
  - Or ..... 1 @ 17/32"; 4 @ 1/2"; 8 @ 7/16"; ..... 6 1/32"
- Width ..... 4"
- Length (When Loaded)
  - Center to Center of Spring Eyes ..... 73 1/2"
  - Center of Front Eye to Seat Center ..... 35 1/2"
  - Center of Rear Eye to Seat Center ..... 38"
- Rebound Clips 4

SPRING BUSHINGS

Outer Diameter
- New ..... 1.762" - 1.765"
- Service ..... 1.794" - 1.797"

Length ..... 4"
Thread ..... 1 3/8" - 6 - U.S.F. Tap
Pitch Diameter ..... 1.2635" - 1.2695"

SHACKLE PINS

Rear Spring Front
- Thread ..... 1 3/8 - 6 A.N.C. Tap
- Pitch Diameter ..... 1.2395" - 1.2435"

All Others
- Thread ..... 1 3/8 - 6 U.S.F. Tap
- Pitch Diameter ..... 1.2395" - 1.2435"

SHOCK ABSORBERS

Make ..... Delco Product
Type ..... Double Acting
Model
- Right Front ..... 1696 - E - 3B - D2
- Left Front ..... 1696 - F - 3B - D2

Steering Gear

Contents of This Section

Related Subjects in Other Sections

The steering mechanism comprises the steering gear assembly, connecting linkage and allied parts of the front axle. The steering gear assembly is connected to steering arm at left hand steering knuckle through the Pitman arm and drag link. Front axle parts, pertinent to steering, are covered in Front Axle (Sec. 1B. of this manual).

Steering gear, figure 2, is cam and roller twin lever type. The only contact between actuating and actuated members of gear is rolling-line-contact between lever studs and cam thread. Clearance between studs and cam can be adjusted by means of adjusting screw and lock nut, accessible from under vehicle, as described under "Steering Gear Adjustments" in this section.

CONSTRUCTION AND OPERATION

The essential operation of the gear is same as conventional type gear except steering effort is transmitted to steering gear proper by means of bevel gears and a universal jointed shaft. The two lever shaft studs, in steering gear proper, are designed to operate in such a manner as to give effective steering with a minimum of steering effort. Cam grooves are cut shallower in straight ahead driving position of each stud to produce a high point in the groove (equal at each stud) that causes closer mesh of studs in groove through mid-position of travel of each stud. At points other than straight ahead driving position, more clearance is provided for studs to allow free action. This feature permits compensation for wear, by adjusting studs into grooves after such wear has occurred at "high point," without causing studs to bind at other points in grooves. Groove sides are cut on a uniform angle designed to fit against stud taper in any position. Thus, it will be seen that varying depth of groove makes for what might be termed a high range of support at those points where groove is shallower. In this manner a very sensitive adjustment is permissible.

Lever shaft is mounted in two bushings located in gear housing. An oil seal assembly is provided at Pitman arm end of lever shaft.

The cam is integral with lower steering shaft, and is mounted in gear housing between two ball bearing assemblies. Lower bearing is adjustable towards upper bearing for removing cam and shaft end play. Ball bearing assembly, pressed into steering column jacket, supports upper end of steering shaft. Lower end of steering shaft is mounted in a single row ball bearing assembly retained in bevel gear housing.

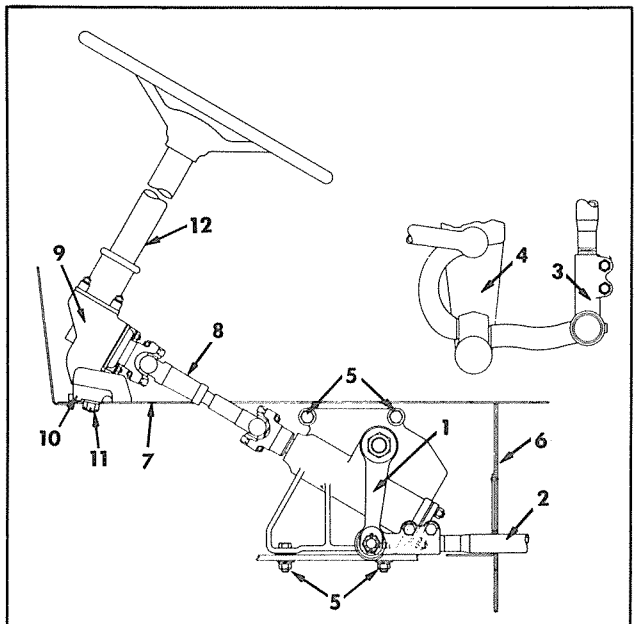
MOUNTING

Steering gear and drag link installation views are shown in figure 1. Steering gear assembly is attached to vehicle understructure by mounting bolts which hold the steering gear housing in place, and is accessible for adjustments or replacement through tool compartment door.

Bevel gear housing is bolted to bevel gear housing bracket which is riveted to coach floor. Lower end of steering column jacket is riveted to bevel gear housing, upper end is retained in steering column gear shift housing assembly. Steering column gear shift housing consists of two pieces; the gear shift housing which is bolted to instrument panel supports, and the housing cap which is bolted to housing. Removal of housing cap, permits removal of steering column without disturbing gear shift controls, and also provides means of correcting steering column misalignment.

Steering gear universal joint is housed under steering gear removable cover and is accessible for inspection or removal after cover is removed.

STEERING GEAR



1 Pitman Arm	7 Floor Panel
2 Drag Link	8 Propeller Shaft
3 Tie Rod	9 Bevel Gear Housing
4 Front Axle	10 Housing Bracket
5 Mounting Bolts	11 Bracket Stud
6 Bulkhead	12 Steering Column

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Figure 1—Steering Gear Installation Views

INSPECTION AND LUBRICATION

The following light maintenance operations include items which should be periodically inspected and minor repairs and adjustments which may be accomplished without removing the steering gear from the vehicle.

1. At regular intervals check and tighten, if necessary, all steering gear mounting bolts, Pitman arm retaining nut, and housing side cover attaching bolts.

2. Inspect drag link and steering gear adjustments and adjust if necessary. Refer to "Steering Gear Adjustments," covered later in this section, for method of checking steering gear adjustment and refer to "Steering Drag Link" for drag link information.

3. Lubricate steering gear and allied units as directed in Lubrication (Sec. 13, of this manual).

STEERING GEAR ADJUSTMENTS

Before an attempt is made to remedy steering difficulties by adjusting steering gear, other factors which might cause hard or otherwise unsatisfactory steering should be checked. Reference should be made to Trouble Shooting (Sec. 21 in this manual), for steering gear trouble diagnosis and remedial measures. It is important that steering gear be properly adjusted to assure satisfactory steering and prevent excessive wear of parts. Adjustments for thrust of ball bearings on cam, for minimum backlash of tapered lever shaft studs in cam groove, for bevel gear backlash; are provided. Always check cam bearing adjustment, and adjust if necessary, prior to making lever shaft backlash adjustment. Before making adjustments, following preliminary operations are necessary:

1. Disconnect steering drag link from Pitman arm so that steering gear will be free of all load. Note relative positions of parts. Link should remain disconnected until all adjustments are completed.

2. Tighten steering gear housing to under structure mounting bolts.

CAM BEARING ADJUSTMENT (Fig. 2)

Before making this adjustment, loosen the lever shaft thrust adjusting screw (8, fig. 2) to free the studs in the cam groove, then proceed as follows:

1. Loosen four gear housing lower cover to housing stud nuts then move housing cover (12) until shims (11) are accessible.

2. Shims are of .002,, .003, and .010 inch thickness. Clip and remove one of the thinner shims, then tighten four cover nuts securely.

3. Test adjustment. Cam bearing adjustment is correct when a barely perceptible drag is felt when steering wheel is turned, while gripped lightly at rim, with thumb and forefinger. If steering wheel will not turn freely, adjustment is too tight.

4. If adjustment is still not correct, remove or replace shims until correctly adjusted.

NOTE: If it is necessary to install new shims to obtain correct cam bearing adjustment, shims may be cut in half and inserted between other shims temporarily. Be careful, however, that ends of shim do not overlap and that half-shims do not drop out while tightening cover nuts. Shims installed in this manner must always be replaced by whole shims at earliest opportunity.

LEVER SHAFT THRUST ADJUSTMENT (Fig. 2)

Since larger portion of driving is done when traveling in an approximately straight line, more wear occurs in steering gear within about one-quarter wheel turn either side of straight-ahead position. For this reason, within this range, width of cam groove is narrower than elsewhere, making it possible to adjust gear for wear without binding in extreme positions. It is important to note that lever shaft thrust must be adjusted with lever shaft in position where width of cam groove is narrowest; that is within one half wheel turn of straight-ahead driving range.

STEERING GEAR

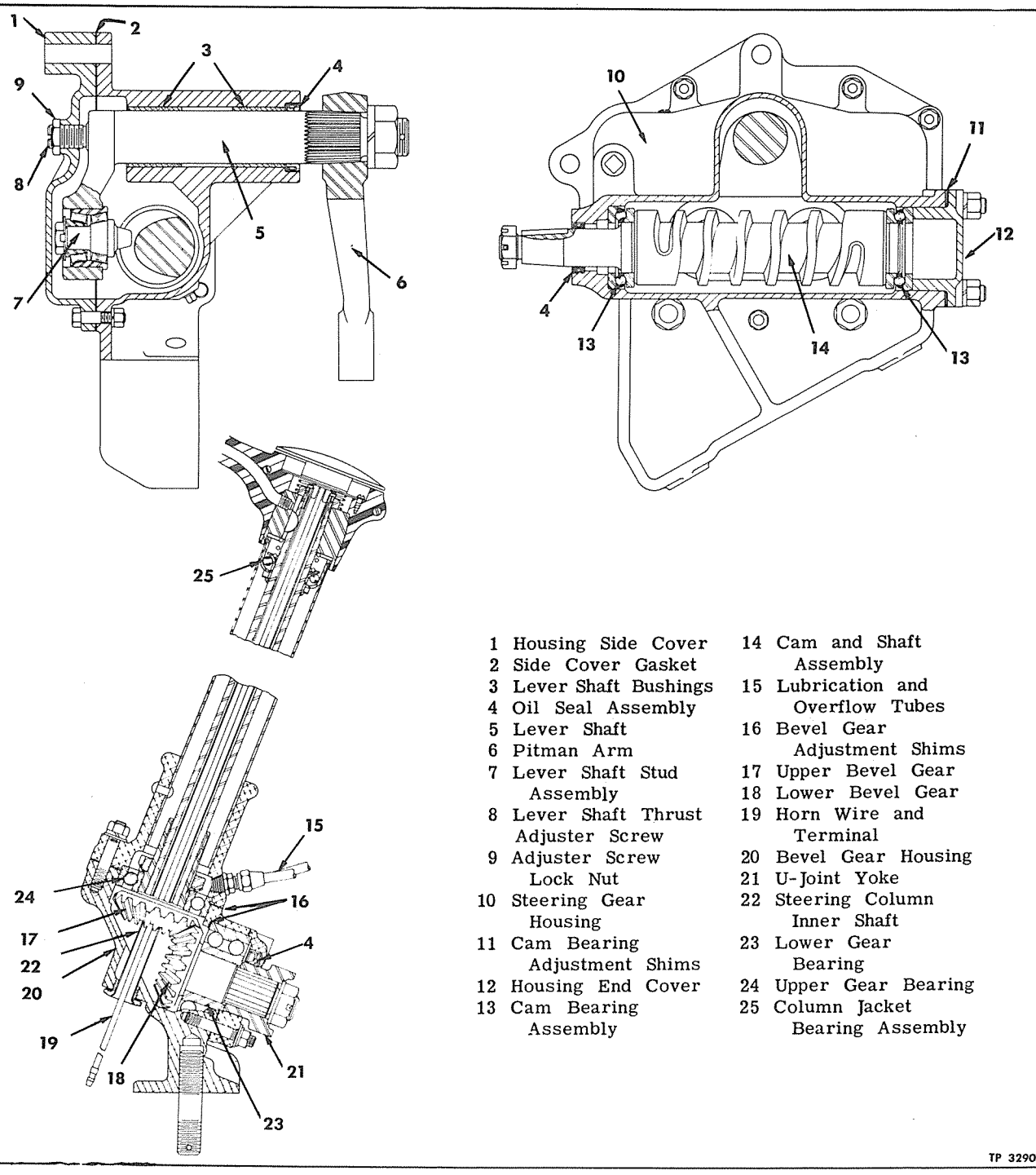


Figure 2—Steering Gear Construction

Lever shaft thrust adjustment is made by means of adjusting screw, (8) located in side cover at inner end of lever shaft. Be sure cam bearings are adjusted properly, then proceed as follows:

1. To gain access to lever shaft adjuster screw, remove driver's seat, then remove air duct cover, air duct cover seal, and elbow turn assembly from air duct.

2. Disconnect steering drag link at Pitman arm.

3. Center steering gear by turning steering

STEERING GEAR

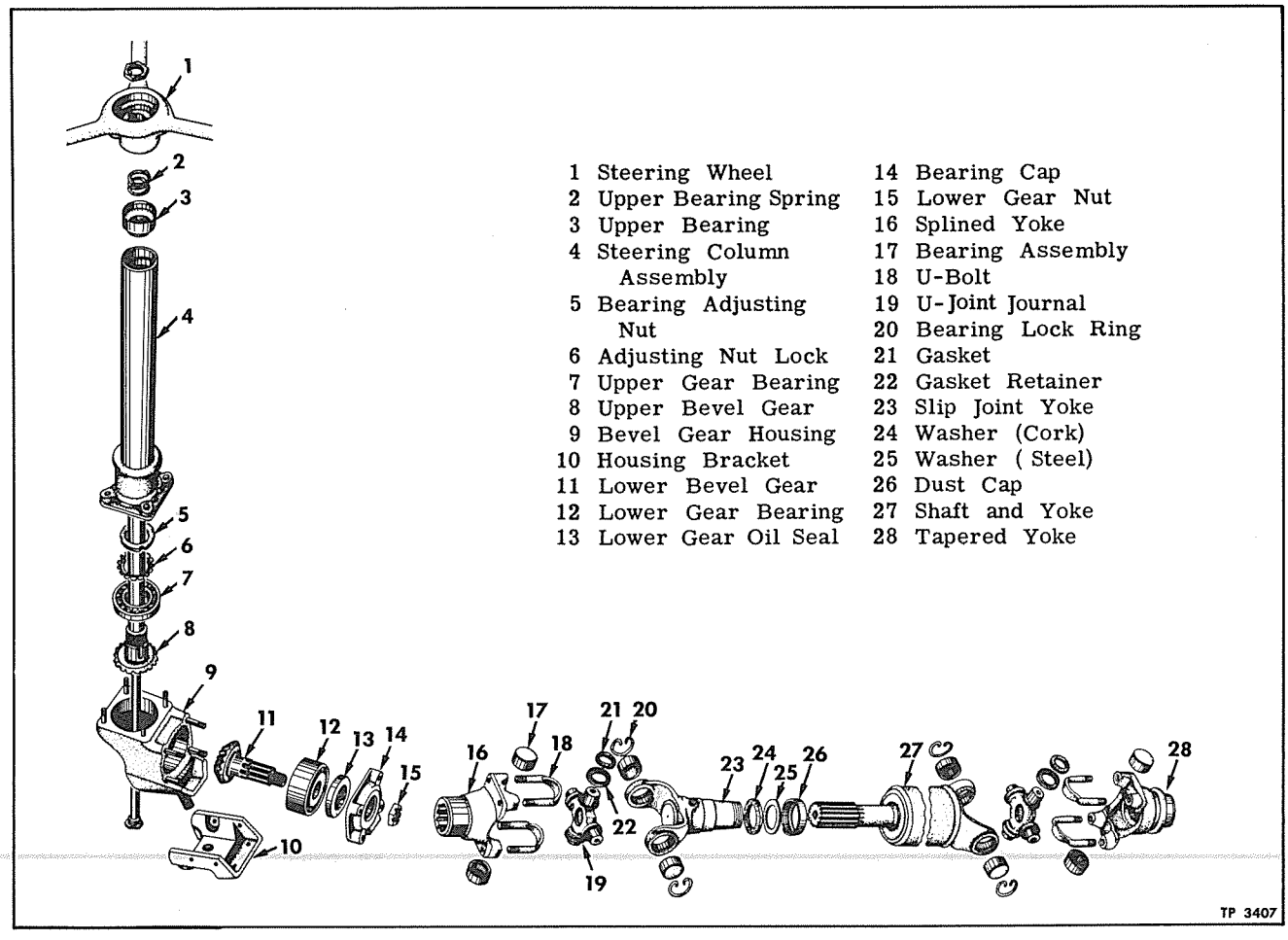


Figure 3—Steering Column and Propeller Shaft Components

wheel from right or left extreme, carefully counting number of turns, then rotate wheel back exactly halfway. Mark wheel at top or bottom center with a piece of tape.

4. Loosen lock nut (9) on adjusting screw (8), then tighten adjusting screw until all lever shaft thrust is removed.

5. Back off adjusting screw until only a very slight drag is felt through the mid-position when turning steering wheel slowly from one extreme position to the other.

6. Tighten lock nut securely and again test adjustment to make sure that lever shaft thrust did not change when lock nut was tightened. Connect steering drag link to Pitman arm.

When steering gear is properly adjusted, lever shaft will have slight amount of thrust. This is necessary to insure proper lubrication, because film of lubricant must separate lever studs and walls of cam groove at all times or rapid parts wear will result. A closer adjustment will not correct any steering condition, but will serve only to damage and wear parts and impair operation.

ADJUSTING BEVEL GEAR BACKLASH (Fig. 2)

Proper adjustment of bevel gears (17 and 18) must be maintained to assure correct gear contact and normal function of the gears and bearings. Upper bevel gear (17) is mounted on single row ball bearing (24) which is retained with a special lock nut and lock washer. Lower bevel gear (18) is mounted on double row ball bearing (23); the inner race of which is fixed by shoulder of gear and universal joint yoke; the outer race is bearing cap and shoulder of housing.

During the adjustment, gears should be revolved to make sure that there are no "high spots" or bind in gears. If gears are adjusted too tight, the resulting bind will cause hard steering and excessive load on bearings; also, if gears are adjusted too loose, operation will be rough and noisy.

Upper bevel gear is adjusted by adding or removing shims (16) between upper bearing cap and bevel gear housing (20). Bevel gear housing is accessible after steering gear removable cover assembly has been removed.

Lower bevel gear is adjusted by adding or removing shims (16) between inner side of double row ball bearing outer race and bevel gear housing.

Adjust until there is no perceptible backlash between gears. Add shims to increase backlash remove shims to decrease backlash.

ADJUSTING STUD-ROLLER BEARING UNITS

The foregoing adjustments will suffice in nearly every instance, but in some cases it may be necessary to adjust stud roller bearing units in lever shaft, in which case steering gear must be removed from chassis and disassembled in order to make lever shaft accessible. Refer to "Steering Gear Overhaul," later in this section for steering gear removal and disassembly procedures.

The roller bearings should be preloaded at all times. Adjust to a heavy drag. Used units should be set lighter than new replacement units but never below a minimum stud turning torque of 5 to 11 inch-pounds. Factory adjustments on new units are within these limits.

Stud roller bearing adjustment may be accomplished as follows: (Key numbers refer to fig. 7)

1. Wash stud bearings (9) in kerosene and lubricate with light oil.

2. Place lever stud (8) in vise with nut (4) up, taking care to grip straight cylindrical portion only. Extreme care should be exercised to pre vent damage to stud bearing surfaces.

3. Straighten out prong of lock washer (5). Tighten stud nut (4) securely then back off nut slightly. Tap both sides of lever shaft (10) with soft metal hammer to seat bearings (9) properly.

4. Rotate stud (8) back and forth and test adjustment.

5. When adjustment is within correct limits, lock adjustment by bending prong of lock washer (5) against a side of the nut (4). Bend the prong that is at right angle to a side of the nut. DO NOT USE A LOCK WASHER TWICE UNLESS PRONGS USED BEFORE HAVE BEEN REMOVED.

6. Lubricate stud assembly with steering gear lubricant specified in Lubrication (Sec. 13 of this manual).

STEERING GEAR OVERHAUL

Whenever, due to excessive wear, the steering gear assembly cannot be adjusted properly, or if during adjustment, "lumpy" or rough action is noticed, it will be necessary to overhaul the steering gear assembly. The steering gear should be removed from vehicle for all overhaul or repair operations.

STEERING GEAR REMOVAL (Fig. 3)

1. Remove driver's seat, then remove steering gear removable cover assembly and cover seal.

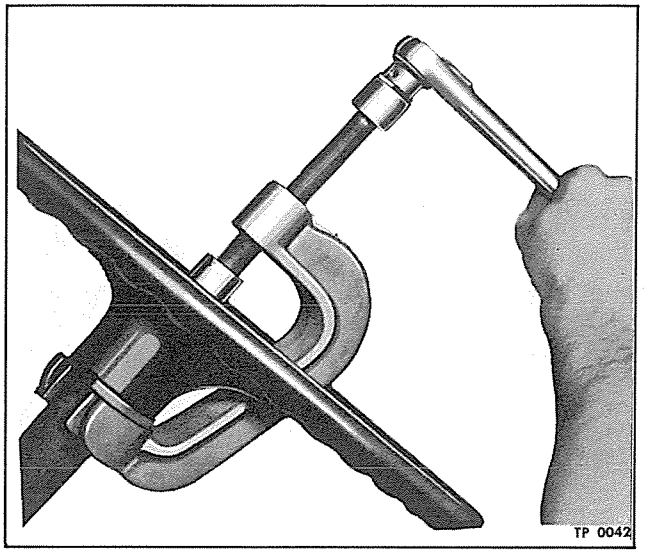


Figure 4—Removing Steering Wheel—Using Tool No. J-452-G (Typical)

2. Depress horn button and turn to left to disengage lugs on button from base plate assembly. Remove horn button, horn contact cup, contact spring, and contact cap. Remove screws which attach base plate assembly to steering wheel, then remove base plate assembly and spring.

3. Remove steering wheel retaining nut, then, using steering wheel puller (Tool No. J-452-G) as illustrated in figure 4, pull wheel off upper steering shaft and remove key from keyway in upper shaft.

4. Remove four cross-recess screws which bolt steering column gear shift housing cap to housing assembly, then remove housing cap.

5. Disconnect universal joint, at bevel gear housing, by removing U-bolts (18) which attach journal (19) of joint to splined yoke (16).

6. Disconnect lubrication and overflow tubes (15, fig. 2) at bevel gear housing.

7. Remove left hand fog light as directed in Lighting (Sec. 7G in this manual), then, working through fog lamp opening, remove cotter pin and nut from stud which attaches bevel gear housing to vehicle floor.

8. Disconnect horn wire from socket, then remove column assembly from vehicle.

9. Steering gear housing is accessible through tool compartment, as shown in figure 5. Working through tool compartment door, disconnect steering drag link from Pitman arm, as directed under "Steering Drag Link," later in this section.

10. Disconnect universal joint, at steering gear housing, by removing U-bolts which attach U-joint journal to tapered yoke (28). Remove steering gear propeller shaft.

STEERING GEAR

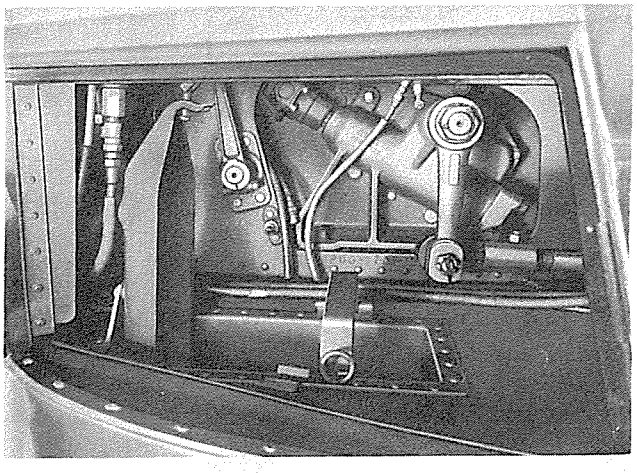


Figure 5—Steering Housing Accessibility

11. Remove four steering gear housing to vehicle understructure attaching bolts (5, fig. 1), then remove housing through tool compartment door.

12. Remove Pitman arm retaining nut and lock washer. Note aligning marks on Pitman arm and lever shaft. If marks are not clearly discernible, punch mark both parts, then remove Pitman arm using a suitable puller.

NOTE: Pitman arm may be removed from lever shaft while steering gear is installed in vehicle if so desired.

STEERING GEAR DISASSEMBLY

Prior to disassembly operations, be sure that steering gear, work bench and tools are clean. Steering gear parts must be kept free from dirt. When mounting steering gear in vise or other holding fixture, do not grip housing too tightly or housing may be damaged.

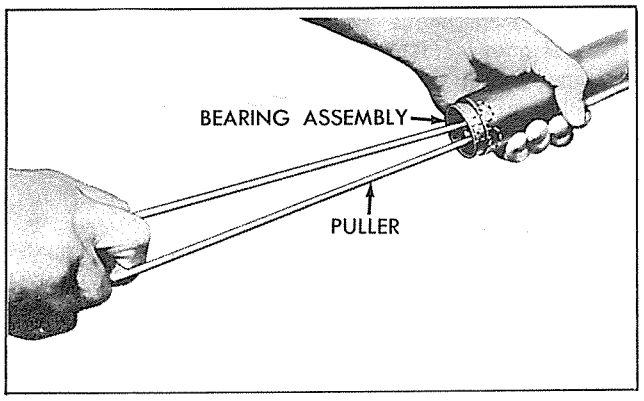


Figure 6—Removing Upper Jacket Tube Bearing —Using Tool No. J-489

COLUMN DISASSEMBLY (Fig. 3)

1. Remove nuts and lock washers from studs which attach steering column assembly (4) to bevel gear housing (9) then remove column assembly.

2. Remove upper bearing (3) from steering column assembly (4), using tool No. J-489 as shown in figure 6.

3. Remove bearing adjusting nut (5), adjusting nut lock (6), and upper gear bearing (7) from steering shaft, then pull steering shaft and upper bevel gear (8) out of bevel gear housing (9).

4. Remove cotter pin and lower gear nut (15) from lower bevel gear (11), then remove splined yoke (16) from lower bevel gear.

5. Remove nuts and lock washers from bevel gear housing studs, then remove bearing cap (14) and gasket. Press lower gear oil seal (13) out of bearing cap.

6. Using suitable tool, remove lower gear bearing (12) from gear housing, then remove lower bevel gear (11). Remove all old adjusting shims (16) from housing.

7. If necessary, horn wire tube may be removed after tube bushing has been removed from bottom of bevel gear housing.

HOUSING DISASSEMBLY (Fig. 7)

1. Remove lock nut (1) and turn lever shaft adjusting screw (2) out a few turns.

2. Place pan under assembly to catch lubricant, then remove gear housing side cover (3) and side cover gasket.

3. After lubricant has drained out of housing, slide lever shaft assembly (10) out of housing, first being sure outer end of lever shaft is free from any burrs which might damage housing bushings as shaft is withdrawn.

4. Disassemble lever shaft assembly. Bend prong of lock washer (5) away from stud nut, (4) then remove stud nut. Remove bearing inner race (6), bearings (9), and stud (8) from bearing outer race (7), then press bearing outer race out of lever shaft.

5. Remove cotter pin and nut which retains universal joint yoke on cam and shaft assembly then remove yoke and woodruff key from shaft.

6. Remove four studs which attach gear housing lower cover to gear housing, then remove lower cover shims and lower cam bearing assembly from gear housing.

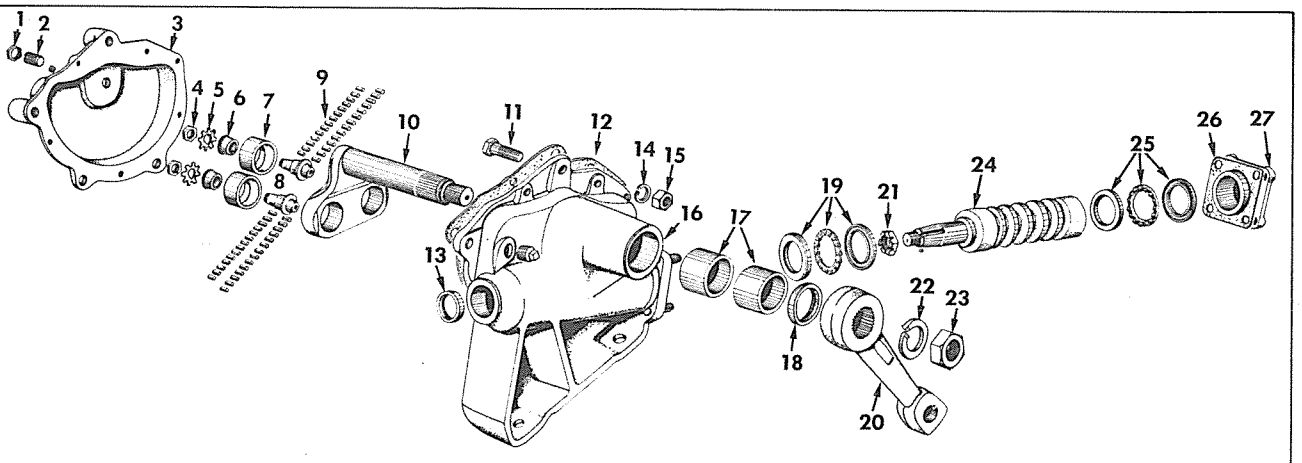
7. Press cam and shaft assembly out of gear housing, then remove upper cam bearing assembly housing.

8. Using suitable tool, remove lever shaft oil seal assembly and cam shaft oil seal assembly (13) from gear housing.

CLEANING AND INSPECTION (Figs. 3 and 7)

Clean all parts thoroughly in clean gasoline

STEERING GEAR



1 Adjusting Screw Nut	10 Lever Shaft	19 Cam Bearing Assembly
2 Adjusting Screw	11 Side Cover Bolt	20 Pitman Arm
3 Housing Side Cover	12 Side Cover Gasket	21 Cam Shaft Nut
4 Stud Nut	13 Cam Shaft Oil Seal	22 Lever Shaft Washer
5 Bearing Lock Washer	14 Washer	23 Lever Shaft Nut
6 Bearing Inner Race	15 Nut	24 Cam
7 Bearing Outer Race	16 Steering Gear Housing	25 Cam Bearing Assembly
8 Lever Shaft Stud	17 Lever Shaft Bushing	26 Shim
9 Roller Bearing	18 Lever Shaft Oil Seal	27 Lower Cover

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Figure 7—Steering Gear Components

or other suitable cleaning fluid. Soak cam bearing assemblies, column jacket bearing assembly, and lever shaft stud bearings in cleaner to dissolve any particles of hard grease. When all parts are clean, perform the following inspection operations:

1. Inspect cam bearings for excessive wear, pitted balls, or broken or damaged retainers. If any of these conditions are present, in an aggravated state, replace cam bearing.

2. Examine stud roller bearings for pitting, chips, or broken rollers. If any rollers have to be replaced, it will be necessary to replace the complete set of rollers. Satisfactory operation cannot be obtained if old and new rollers are installed in the same assembly.

3. Check helical cut grooves of cam and shaft for roughness. Grooves must be smooth and free from scores. Check shaft for bent or sprung condition.

4. Conical contact surfaces of lever shaft studs which ride in cam grooves, must be smooth and round. However, small flat spots may be disregarded.

5. Check action of column jacket bearing assembly. If action is unsatisfactory, or bearings show signs of wear, or retainers are damaged; new bearing assembly should be installed.

6. Lever shaft and Pitman arm should be inspected to make sure they are not bent or twisted and that splines are in good condition.

7. Insert lever shaft in gear housing and check clearance between shaft and housing bushings. If clearance is excessive and diameter of lever shaft is within limits given in "Specifications," at end of this section, bushings should be replaced. When installing new bushings, press bushings into housing until they are positioned as shown in figure 2.

8. Check action of universal joint. If action is not smooth and free, universal joint should be disassembled, cleaned, and inspected for defective parts which would impair action.

9. Inspect gear housing and housing side cover for cracks, distortion, and condition of all tapped holes. Replace parts if unfit for further service.

STEERING GEAR ASSEMBLY

Assembly of steering gear parts must not be attempted in dirty surroundings. Parts must be kept absolutely clean since even small particles of dirt, in working parts of steering gear, can cause excessive wear.

HOUSING ASSEMBLY (Fig. 7)

1. Insert steel washer and cork washer into gear housing, then press lever shaft oil seal assembly into gear housing until it seats solidly in housing. NOTE: Use of a new oil seal is recommended, but oil seal may be used if in exceptionally good condition.

2. Assemble lever shaft assembly. Press outer

STEERING GEAR

bearing races (7) into lever shaft (10) with flanged end of races towards Pitman arm end of lever shaft. Coat inside surface of outer race with soft cup grease or vaseline to hold rollers in position during assembly, then install rollers (9), stud (8), inner race (6), lock washer (5), and lock nut (4) in outer race. Adjust as directed previously under "Adjusting Stud Roller Bearing Units."

3. Install upper cam bearing unit in gear housing, making sure upper race seats solidly in housing.

4. Place cam and shaft assembly (24) in gear housing, then press lower cam bearing unit (25) into housing.

5. Place shims (26) over lower cover, position cover on housing, then install four attaching studs using new lock washers. Adjust cam bearing clearance as previously directed under "Cam Bearing Adjustment" in this section.

6. Insert woodruff key in slot in upper end of cam and shaft assembly, position universal joint lower yoke on shaft, then install retaining nut (21) and new cotter pin.

7. Slide lever shaft assembly into gear housing being careful not to nick or score housing bushings or oil seal.

8. Place new side cover gasket on gear housing, position side cover on housing, then install attaching studs, using new lock washers. Adjust lever shaft thrust as previously directed under "Lever Shaft Thrust Adjustment" in this section.

9. Fill gear housing with lubricant specified in Lubrication (Sec. 13 of this manual).

COLUMN ASSEMBLY (Fig. 3)

1. Place upper bevel gear shims (steel) on bevel gear housing studs and place lower bevel gear shims (brass) in bevel gear housing. NOTE: Shims are available in .003 and .010 inch thicknesses and an average of three (3) each are required.

2. Position lower bevel gear (11) in bevel gear housing (9), then install lower gear bearing (12).

3. Press bearing oil seal (13) into bearing cap (14), position new gasket on bevel gear housing studs, then install bearing cap (14). Install splined yoke (16).

4. If horn wire tube was removed, place tube in housing and install tube bushing.

5. Place steering shaft and upper bevel gear (8) in housing (9), then install upper gear bearing (7), adjusting nut lock (6) and bearing adjusting nut (5). Tighten nut until inner race of upper gear bearing rests solidly on shoulder of bevel gear, then lock nut in place.

6. Press upper bearing (3) into steering column assembly (4) until shoulder of bearing retainer rests on column jacket.

7. Position column assembly (4) on bevel gear housing studs, then install new lock washers and nuts, tightening nuts securely.

8. Adjust bevel gears as directed previously, under "Adjusting Bevel Gear Backlash," in this section.

Steering Gear Installation (Fig. 1)

1. Place steering gear housing into position, then attach to vehicle under structure with four mounting bolts.

2. Place steering propeller shaft assembly into position, then install U-bolts which attach U-joint journal to tapered yoke mounted on cam and shaft assembly.

3. Position steering column assembly on bevel gear housing bracket, then, working through fog lamp opening, install nut and new cotter pin on bevel gear housing stud.

4. Insert horn wire terminal into connector, then install fog lamp as directed in Lighting (Sec. 7G of this manual).

5. Position U-joint journal in splined yoke, mounted on shaft of lower bevel gear, and secure with U-bolts. Connect lubrication and overflow tubes (15, fig. 2) to fittings in bevel gear housing.

6. Place housing cap on steering column gear shift housing and install four cross recess screws, tightening screws securely.

7. After placing Woodruff key in slot in upper shaft, position steering wheel on shaft. Install steering wheel retaining nut and tighten securely.

8. Place lower contact spring over steering wheel retaining nut, then install base plate assembly in steering wheel. Install contact cap, contact spring, horn contact cup, and horn button in center of steering wheel.

9. Place vehicle wheels in straight-ahead position and turn steering wheel to center of steering gear travel. Install Pitman arm on end of lever shaft aligning mark on arm with mark on shaft. Install new lock washer then secure Pitman arm with nut. Checking front end alignment at this time is also recommended.

10. Assemble and connect drag link to Pitman arm as instructed later under "Steering Drag Link" in this section.

11. Reinstall steering gear removable cover seal, steering gear removable cover, and driver's seat.

STEERING DRAG LINK

Steering drag link assembly is three piece type, comprised of drag link and two end assemblies. As shown in figure 8, drag link ends are roller bearing type and incorporate an adjustment feature which automatically compensates for wear on bearing surfaces. Both end assemblies are

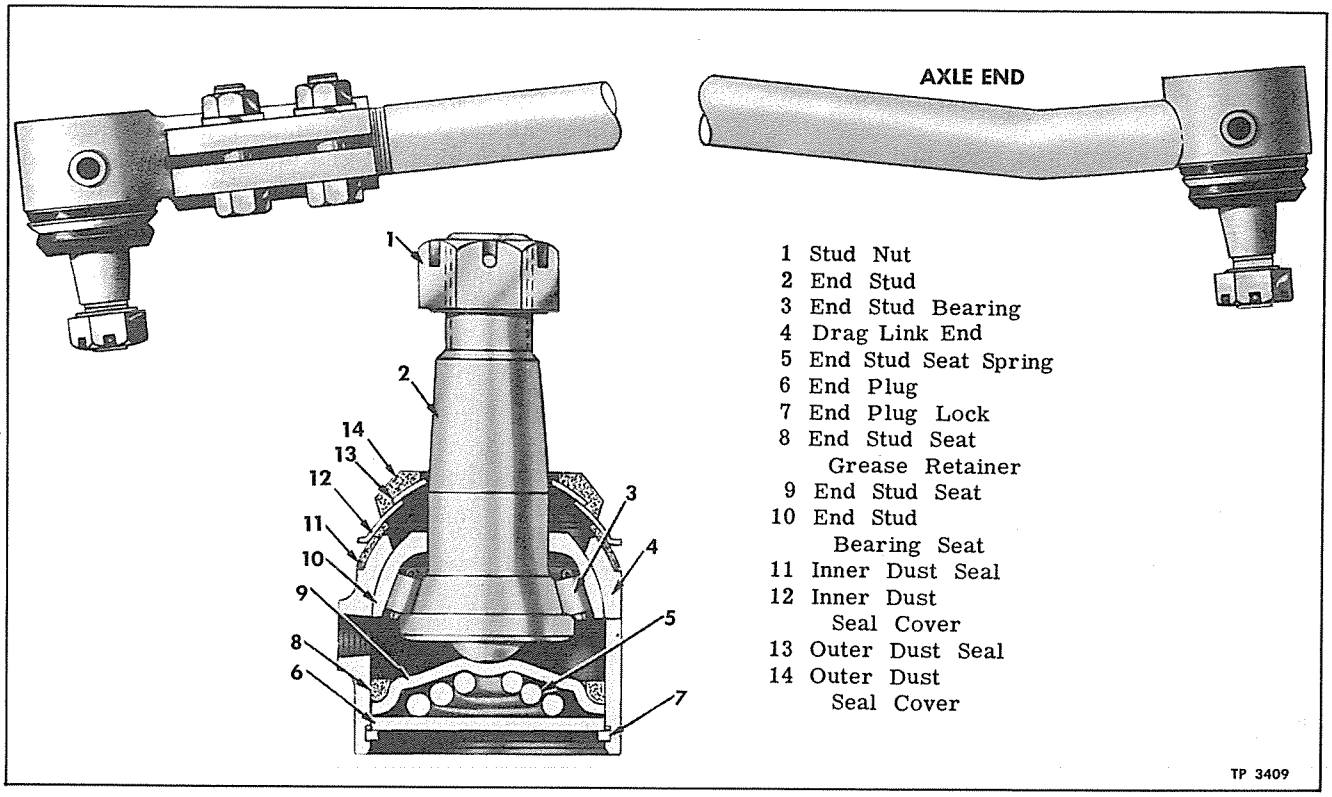

Figure 8—Steering Drag Link

identical, except, end assembly at Pitman arm screws onto drag link, to provide for length adjustment, while end at axle is integral with link. Drag link end, at Pitman arm, is retained on drag link with clamp bolts. Drag link installation is shown in figure 1.

MAINTENANCE

Linkage between steering gear and front axle definitely affects steering action if parts are out of adjustment, bent, or twisted. Check steering geometry and front wheel alignment when steering linkage is repaired or replaced.

Drag link end stud nuts must be kept tight or stud holes in steering arm and Pitman arm may become enlarged as a result of excessive looseness. Subsequent tightening of stud nuts may draw studs into arms so far, that dust cover parts may be damaged during sharp turns.

Drag link ends are equipped with lubrication fittings and should be lubricated as directed in Lubrication (Sec. 13 of this manual).

LENGTH ADJUSTMENT

It should not be necessary to alter length of drag link except when new link is installed. If necessary to adjust drag link length, proceed as follows:

1. Connect rear drag link end to axle steering arm. Be sure drag link end is thoroughly lubricated.

2. Locate center of steering movement by turning steering wheel from right extreme to left extreme, counting the number of turns. Then back up exactly half way. With front wheels in straight ahead position, front ball socket of drag link should fit on Pitman arm without changing position of Pitman arm or front wheels.

3. If parts do not assemble correctly, first check all linkage for bends or distortion. If none of the drag link parts are found to be bent or twisted, loosen clamp bolts, then turn front drag link end enough to obtain length to permit installation of end stud in Pitman arm without twist or bind.

4. Tighten clamp bolts firmly, then test adjustment. Front wheels should turn from right to left extremes without noticeable binding at drag link ends.

DRAG LINK END REPAIR

Normal wear on bearing surfaces in drag link end will result in increased overall height of assembly. If excessive play is noted, drag link ends must be removed and disassembled for replacement of worn parts.

STEERING GEAR

REMOVAL AND DISASSEMBLY (Fig. 8)

1. Disconnect drag link ends from steering arms and Pitman arm by removing cotter pins and nuts from end studs and driving studs out of arms.
2. Loosen clamp bolt nuts and unscrew drag link end from drag link.
3. Remove outer dust seal cover (14), outer dust seal (13), inner dust seal cover (12), and inner dust seal (11) from end stud (2).
4. Pry end plug lock (7) out of drag link end (4), then remove end plug (6), end stud seat spring (5), end stud seat (9), grease retainer (8), end stud (2), end stud bearing (3), and end stud bearing seat (10) from drag link end.

CLEANING AND INSPECTION

1. Immerse all parts, except dust seal covers (12 and 14) in suitable cleaning fluid, use a stiff bristle brush as required, and clean parts thoroughly.
2. Check all parts for wear or corrosion and discard parts that are badly damaged.
3. Check tension of end stud seat spring (5). Discard spring if tension is not within limits given in "Specifications" at end of this section.
4. Carefully inspect rollers in end stud bearing assembly (3) for roughness or flaking. If rollers will not rotate freely in retainer, bearing assembly should be replaced.

ASSEMBLY AND INSTALLATION

Keep all parts clean when performing assembly operations. If dirt or grit is allowed to get into drag link end when assembling, premature and excessive parts wear will result.

1. Lubricate all parts with lubricant specified in "Lubrication" (Sec. 13 of this manual), then place end stud bearing (3) and end stud bearing seat (10) on end stud (2).
2. Insert stud and bearing assembly into drag link end (4), then press grease retainer (8) over end of end stud seat (9). Place stud seat in drag link end, then install end stud seat spring (5), and end plug (6). Secure parts in drag link end (4) with end plug lock (7).
3. Install on threaded end of stud, in following order, inner dust seal (11), inner dust seal cover (12), outer dust seal (13), and outer dust seal cover.
4. Install drag link end assembly on drag link, but do not tighten clamp bolt nuts.
5. Place drag link in position on vehicle, then connect end stud to steering arm at axle.
6. Adjust length, as previously directed under "Length Adjustment." in this section, then lubricate as directed in Lubrication (Sec. 13 of this manual).

SPECIAL TOOLS

Reference is made to special tools in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however, are not supplied by GMC Truck & Coach Division. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

No.	Name	Code
J-452G	Steering Wheel Puller	KM
J-489	Jacket Bearing Remover	KM

Code	Vendor	Address
KM	Kent Moore Organization	Detroit, Mich.

SPECIFICATIONS

STEERING GEAR

Make	Ross Gear & Tool Co.
Type	Cam & Roller - Twin Lever
Gear Ratio	23 to 1
Steering Wheel Diameter	22 in.

CLEARANCE

Housing diameter at lever shaft bushing	1.873 - 1.875 in.
Lever Shaft bushing length	
Inner Bushing	1.250 - 1.253 in.
Outer Bushing	1.48 - 1.50 in.
Lever shaft bushing O.D.	1.876 - 1.877 in.
Lever shaft bushing I.D.	1.7485 - 1.7500 in.
Lever shaft diameter	1.7465 - 1.7475 in.
Clearance - bushing to shaft	0.001 - 0.0035 in.
Clearance - bushing to housing	(0.001 - 0.004 in.) Tight
Lever shaft stud bearing	
Outer race - O.D.	1.938 - 1.939 in.
Lever shaft stud hole diameter	1.936 - 1.937 in.
Clearance - race to shaft	(0.001 - 0.003 in.) Tight
Housing diameter at cam bearing seats	2.750 - 2.752 in.
Cam bearing outer race diameter	2.748 - 2.749 in.
Clearance - Race to housing	0.001 - 0.004 in.

ADJUSTMENTS

Cam Bearings

Adjustment type	Shims
Shim sizes available	0.002, 0.003, & 0.010 in.
Adjust to	Slight Drag (see text)

Lever Shaft Thrust

Adjustment type	Adjuster Screw
Adjust to	Slight Drag (see text)

Lever Shaft Stud Bearings

Adjustment type	Adjuster Nut
Adjust to	See Text

Bevel Gears

Adjustment type	Shims
Shim sizes available	0.003 in. & 0.010 in.
Adjust to	No Perceptible Backlash

STEERING DRAG LINK

Type	Adjustable Length
Stud centers	37-7/16 in.

Stud Seat Spring

Free length	3/4 in.
Lbs. pressure at 1/2 in.	350 - 400 lbs.
Solid Height	27/64 in.

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference - Make note of bulletin number in space below:

NOTES

Transmission

Contents of This Section

Related Subjects in Other Sections

Mechanical transmission (fig. 1), has four forward speeds and one reverse. All mainshaft, reverse idler, and countershaft gears have helical cut teeth and are in constant mesh. Interlocking (sliding) clutches with spur teeth on inner diameter slide on corresponding teeth on clutch gears.

Power is transmitted from transmission to propeller shaft through a spiral bevel gear angle drive unit which forms part of transmission assembly.

Transmission, clutch and engine are mounted as a unit, the weight at rear of which is carried at transmission case. Access to transmission is gained through engine compartment doors.

The terms "Front" and "Rear" as used in following description and illustrations do not apply to the mounted position of transmission in coach. Following the common usage of those terms - "Front" applies to clutch end of transmission, while "Rear" applies to propeller shaft end. Key numbers in text refer to figures 1 and 2.

MAINSHAFT AND GEARS

Mainshaft (71) is supported at rear end by opposed tapered roller bearings (68 and 69) mounted in angle drive case end cover (59). Mainshaft center roller bearing (42) mounted in main case (9) directly in front of bevel pinion (64), supports mainshaft at that point. Front of mainshaft is supported by main drive gear pilot roller bearing (11) mounted in pocket of main drive gear (2). Main drive gear (2) is supported in main case (9) by single row ball bearing (5).

Mainshaft 3rd and 4th speed clutch gear (14) is mounted on splined portion of mainshaft and held in place with mainshaft gears retaining nut (12) and lock washer (13). First and 2nd speed clutch gear is integral with mainshaft.

Mainshaft 1st (39), 2nd (30), and 3rd (22) speed constant mesh gears are each mounted on double row needle bearings. Rows of bearings are separated by spacers.

COUNTERSHAFT AND GEARS

Countershaft (87) is supported at rear by single row ball bearing (85) held on shaft with two lock nuts (84 and 82) and lock washer (83). Front end of shaft is supported on counter shaft front roller bearing (104) which is prevented from coming out of case by clutch housing (10). Inner race of roller bearing (104) is held on shaft by countershaft front bearing nut (106) and retaining washer (105).

Countershaft drive gear (101) and countershaft 3rd speed gear (97) are keyed to shaft and separated by spacer (99). Countershaft 2nd speed gear (95) and countershaft clutch gear (94) are integral with shaft.

Countershaft 1st speed gear (89) is not keyed to shaft, but is carried on bronze bushing (90) and is driven by countershaft sliding clutch (91) carried on countershaft clutch gear (94). Countershaft sliding clutch (91) is operated by reverse shift fork and is engaged in all forward speeds.

TRANSMISSION

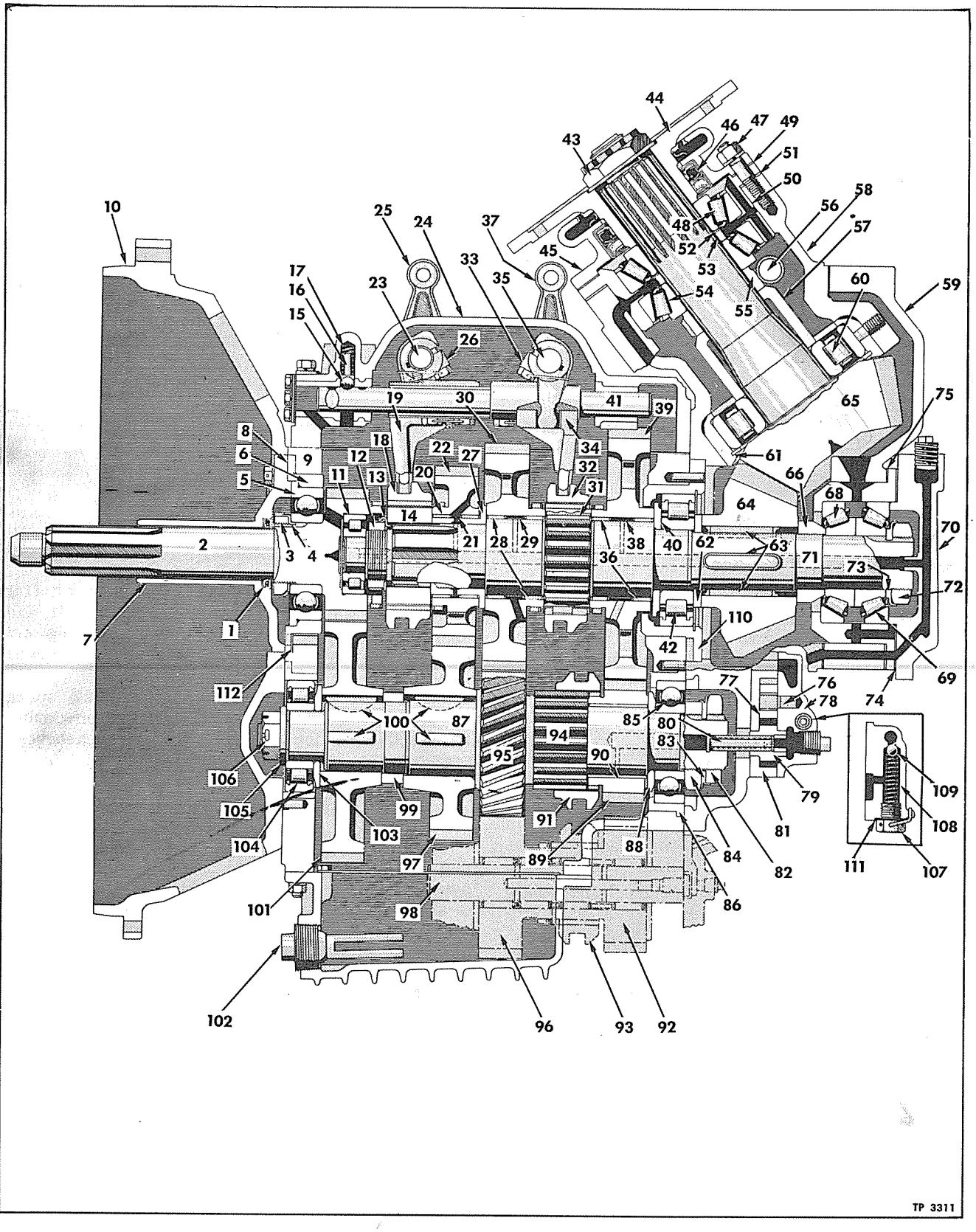

Figure 1—Sectional View of Transmission

SLIDING CLUTCHES SHOWN IN SOLID LINES ILLUSTRATE POSITIONS FOR REVERSE GEAR OPERATION; WHILE DOTTED LINES INDICATE NEUTRAL POSITIONS

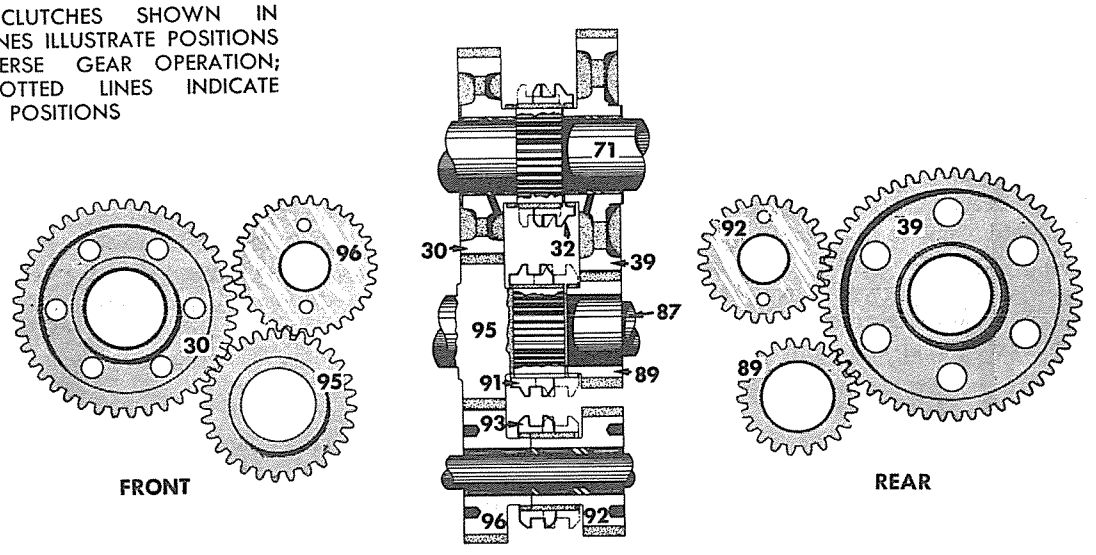

Figure 2—Arrangement of Mainshaft, Countershaft and Reverse Idler Gears and Sliding Clutches for Reverse Operation

1 Oil Seal
2 Main Drive Gear
3 Bearing Lock Nut
4 Lock Washer
5 Main Drive Gear Bearing
6 Bearing Retainer
7 Main Drive Gear Bearing Cap
8 Shims
9 Transmission Main Case
10 Clutch Housing
11 Mainshaft Pilot Bearing
12 Mainshaft Nut
13 Nut Lock Washer
14 3rd and 4th Speed Clutch Gear
15 Poppet Ball
16 Plunger
17 Spring
18 3rd and 4th Speed Sliding Clutch
19 3rd and 4th Speed Shift Fork
20 3rd Speed Gear Bearings
21 Spacer
22 3rd Speed Gear
23 3rd and 4th Speed Shift Shaft
24 Main Case Cover
25 3rd and 4th Speed Shift Lever
26 3rd and 4th Speed Shift Finger
27 3rd and 4th Speed Gear Thrust Collar
28 2nd Speed Gear Bearings
29 Bearing Spacer
30 Mainshaft 2nd Speed Gear
31 1st and 2nd Speed Clutch Gear
32 1st and 2nd Speed Sliding Clutch
33 1st, 2nd, and Reverse Shift Finger
34 1st and 2nd Speed Shift Fork
35 1st, 2nd, and Reverse Shift Shaft
36 1st Speed Gear Bearings
37 1st, 2nd, and Reverse Shift Lever
38 Bearing Spacer
39 Mainshaft 1st Speed Gear
40 1st Speed Gear Thrust Washer
41 1st, 2nd, and Reverse Shift Rod
42 Mainshaft Center Bearing
43 Propeller Shaft Flange Nut
44 Propeller Shaft Flange
45 Bearing Cap
46 Oil Seal
47 Bearing Cap Stud Nut
48 Angle Drive Outer Tapered Bearing
49 Gasket
50 Bearing Retainer
51 Shims
52 Shims
53 Bearing Spacer
54 Angle Drive Inner Tapered Bearing
55 Speedometer Drive Gear
56 Speedometer Driven Gear
57 Spacer
58 Angle Drive Case
59 Angle Drive Case Cover
60 Angle Drive Gear Roller Bearing
61 Snap Ring
62 Bevel Pinion Front Spacer
63 Bevel Pinion Key
64 Bevel Pinion
65 Angle Drive Gear and Shaft
66 Bevel Pinion Rear Spacer
67 Bearing Retainer
68 Mainshaft Inner Rear Bearing
69 Mainshaft Outer Rear Bearing
70 Mainshaft Rear Bearing Cap
71 Mainshaft
72 Mainshaft Rear Bearing Nut
73 Lock Washer
74 Shims
75 Shims
76 Oil Pump Driven Gear Shaft
77 Oil Pump Driven Gear
78 Oil Pump Cover
79 Oil Pump Drive Gear
80 Oil Pump Drive Shaft
81 Oil Pump Housing
82 Outer Nut
83 Lock Washer
84 Inner Lock Nut
85 Countershaft Rear Bearing
86 Countershaft Rear Bearing Retainer
87 Countershaft
88 Countershaft 1st Speed Gear Thrust Washer
89 Countershaft 1st Speed Gear
90 Countershaft 1st Speed Gear Bushing
91 Countershaft Sliding Clutch
92 Reverse Idler Drive Gear
93 Reverse Idler Sliding Clutch
94 Countershaft Clutch Gear
95 Countershaft 2nd Speed Gear
96 Reverse Idler Driven Gear
97 3rd Speed Countershaft Gear
98 Reverse Idler Shaft
99 Spacer
100 Countershaft Gear Key
101 Countershaft Drive Gear
102 Magnetic Drain Plug
103 Drive Gear Retaining Washer
104 Countershaft Front Bearing
105 Bearing Retaining Washer
106 Countershaft Bearing Retaining Nut
107 Relief Valve Plug
108 Relief Valve Spring
109 Oil Pump Relief Valve Ball
110 Mainshaft Center Bearing Retainer
111 Pressure Relief Valve Plug Washer
112 Bearing Retainer Gasket

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Legend for figures 1 and 2

TRANSMISSION

REVERSE IDLER GEARS

Reverse idler driving and driven gears (92 and 96) are mounted on roller bearings, with two bearings in each gear separated by spacers.

Reverse idler gears are separate, revolving independently of each other in all forward speeds. Reverse idler driven gear (96) is in constant mesh with countershaft 2nd speed gear (95) and reverse idler driving gear (92) is in constant mesh with mainshaft 1st speed gear (39). Reverse idler sliding clutch (93) is carried on hub of reverse idler driving gear, and engages both gears during reverse speed.

OIL PUMP

Transmission lubricant is circulated to various points throughout transmission by means of a conventional gear type oil pump mounted on rear side of angle drive case. Oil pump drive is accomplished by fitting end of oil pump shaft (80) into rear end of countershaft (87).

Oil pump drive gear (79) hubs project on both sides and fit into oil pump housing (81). Oil pump driven gear is bushed and turns on shaft (76) pressed into oil pump cover (78). Pump is fitted with spring loaded pressure relief valve, consisting of a ball (109) and spring (108) held in place by screw type plug (107).

OIL SEALS

Spring loaded synthetic rubber type oil seals are used at main drive gear bearing cap (1) and at output shaft bearing cap (46). Spring loaded leather oil seals are used at three points on shift shafts in transmission cover. See figure 4, items 11, 16, and 26.

Before leather seals are installed, they should be soaked in "Neatsfoot" oil or warm engine oil until leather portion of seal is soft and pliable. This procedure will insure an efficient leak-proof seal and also assists in installation. Seal assemblies should be replaced in overhaul periods.

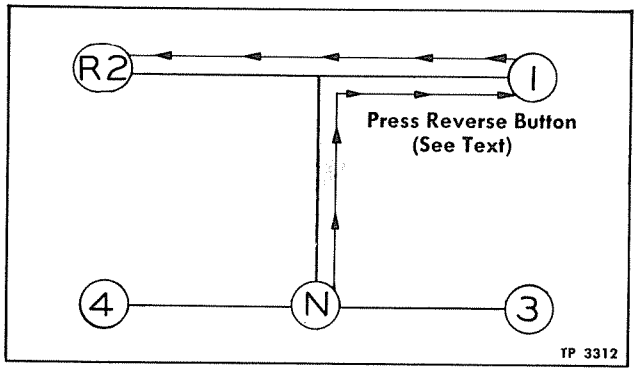


Figure 3—Gear Shifting Diagram

SHIFTING MECHANISM

Gearshift lever is located just below steering wheel at right-hand side of steering column. Mechanical linkage consisting of levers, shaft rods and bell cranks (fig. 5) transmit movement of gearshift lever to mechanism at transmission control cover.

The forward controls at steering column (fig. 10) are enclosed in housing which also encloses steering column above instrument panel.

Reverse Solenoid and Relay (Figs. 7 and 8)

The reverse solenoid, mounted on the transmission assembly is used to furnish pulling force to move shift finger into engagement with reverse speed shift fork.

Reverse solenoid has two coils, one known as a pulling coil and the other referred to as holding coil. Electrical circuit to solenoid is completed by means of solenoid relay mounted on engine compartment panel. Relay is in turn controlled by reverse switch button at panel to the left of driver. Relay control circuit is protected by No. 1 fuse at instrument panel.

When gearshift lever is in 1st speed position the shift finger (19, fig. 4) is in line with notch in reverse speed shift fork, hence pressing the reverse button at this time causes reverse solenoid to operate, thereby moving finger into engagement with the reverse shift fork.

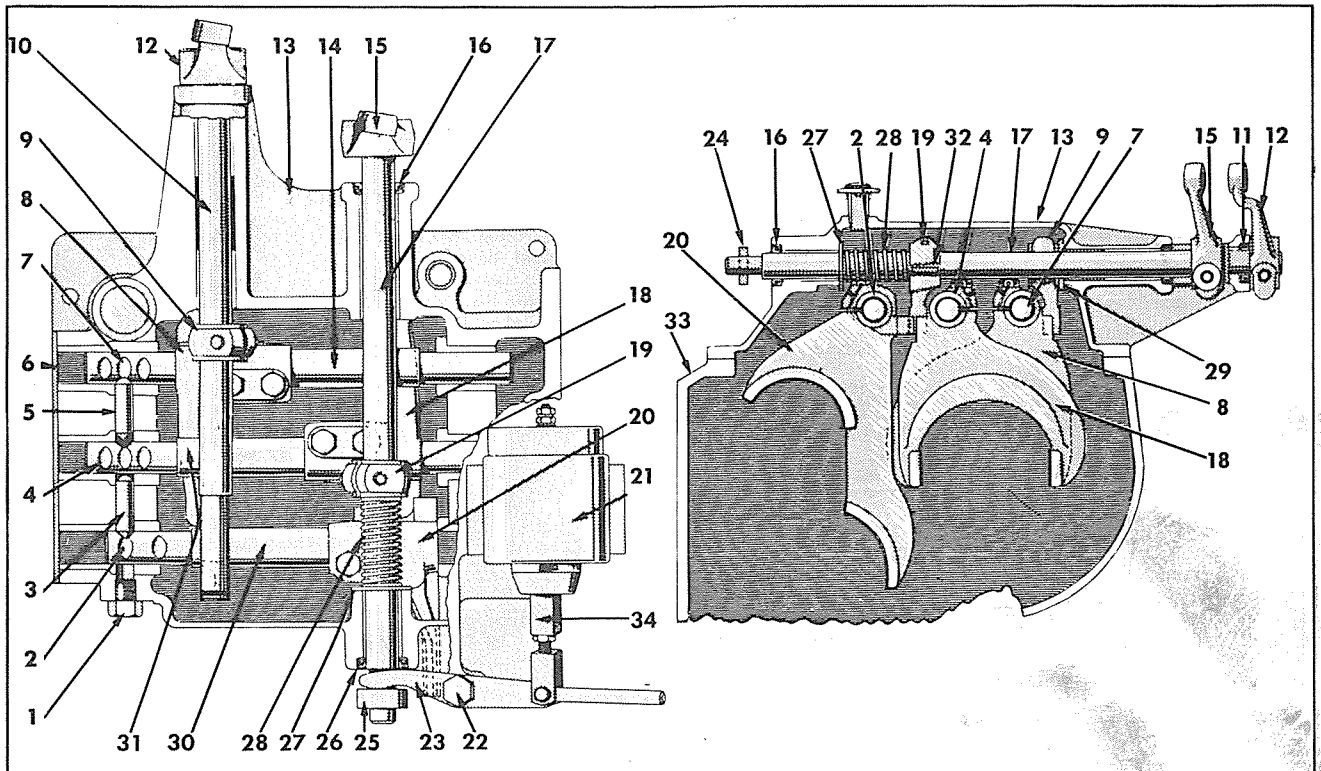
As gearshift lever is moved through reverse shift path (fig. 3), the reverse idler drive and driven gears are locked together by clutch and at same time countershaft 1st speed gear is disengaged from countershaft to become an idler gear for reverse operation.

Both coils in reverse solenoid (fig. 8) are energized to move the shift finger in transmission, but as solenoid plunger reaches end of its travel it strikes a pin which opens a set of points thereby breaking circuit through pulling coil The holding coil remains energized however and will hold the solenoid plunger "in" as long as driver presses the reverse switch button. Refer to Wiring (Sec. 7A of this manual) for wiring, circuits, etc.

OPERATION

Forward speeds are shifted manually by means of shift lever interconnected to transmission shift tower by control rods and levers (fig. 5).

This section describes the path by which power flows through the transmission assembly as vehicle is operated. Shifting diagram shown in figure 3 may be referred to for gearshift lever position for each transmission speed.



1 Interlock Pin Plug
2 Reverse Speed Rod
3 Interlock Pin
4 1st and 2nd Speed Rod
5 Interlock Pin
6 Shift Rod End Plate
7 3rd and 4th Speed Shift Rod
8 3rd and 4th Speed Shift Fork
9 3rd and 4th Speed Shift Finger
10 3rd and 4th Speed Shift Shaft
11 Oil Seal
12 3rd and 4th Speed Shift Lever
13 Cover
14 Stop Sleeve
15 1st, 2nd, and Reverse Speed Shift Lever
16 Oil Seal
17 1st, 2nd and Reverse Speed Shift Shaft
18 1st, and 2nd Speed Shift Fork
19 1st, 2nd, and Reverse Speed Shift Finger
20 Reverse Speed Shift Fork
21 Reverse Solenoid
22 Solenoid Shift Lever Screw
23 Reverse Solenoid Shift Lever
24 Collar Pin
25 Solenoid Fork Collar
26 Oil Seal
27 Washer
28 Reverse Lockout Spring
29 Washer
30 Stop Sleeve
31 Stop Sleeve
32 Shift Finger Key
33 Transmission Main Case
34 Solenoid Linkage

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Figure 4—Sectional View of Transmission Cover

Refer to Operation (Sec. O in this manual) for driver's instructions.

FIRST SPEED

The 1st and 2nd speed sliding clutch (32) is engaged with mating teeth on mainshaft 1st speed gear (39) and the power flow is from main drive gear (2) to countershaft drive gear (101), through countershaft (87) to countershaft 1st speed gear (89), to mainshaft 1st speed gear (39), through sliding clutch (32) and clutch gear (31) to mainshaft (17), through mainshaft to angle drive gears and output shaft (65).

SECOND SPEED

First and 2nd speed sliding clutch (18) is engaged with mating teeth on mainshaft gear (30). Power flow is main drive gear (2) to countershaft drive gear (101), to 2nd speed gear (95), to mainshaft 2nd speed gear (30), to clutch (32) and clutch gear (31), to mainshaft (71), through mainshaft to angle drive gears.

THIRD SPEED

The 3rd and 4th speed sliding clutch (18) is engaged with mating teeth on mainshaft 3rd speed gear (22) and power flow is from main drive gear (2) to countershaft drive gear (101), through

TRANSMISSION

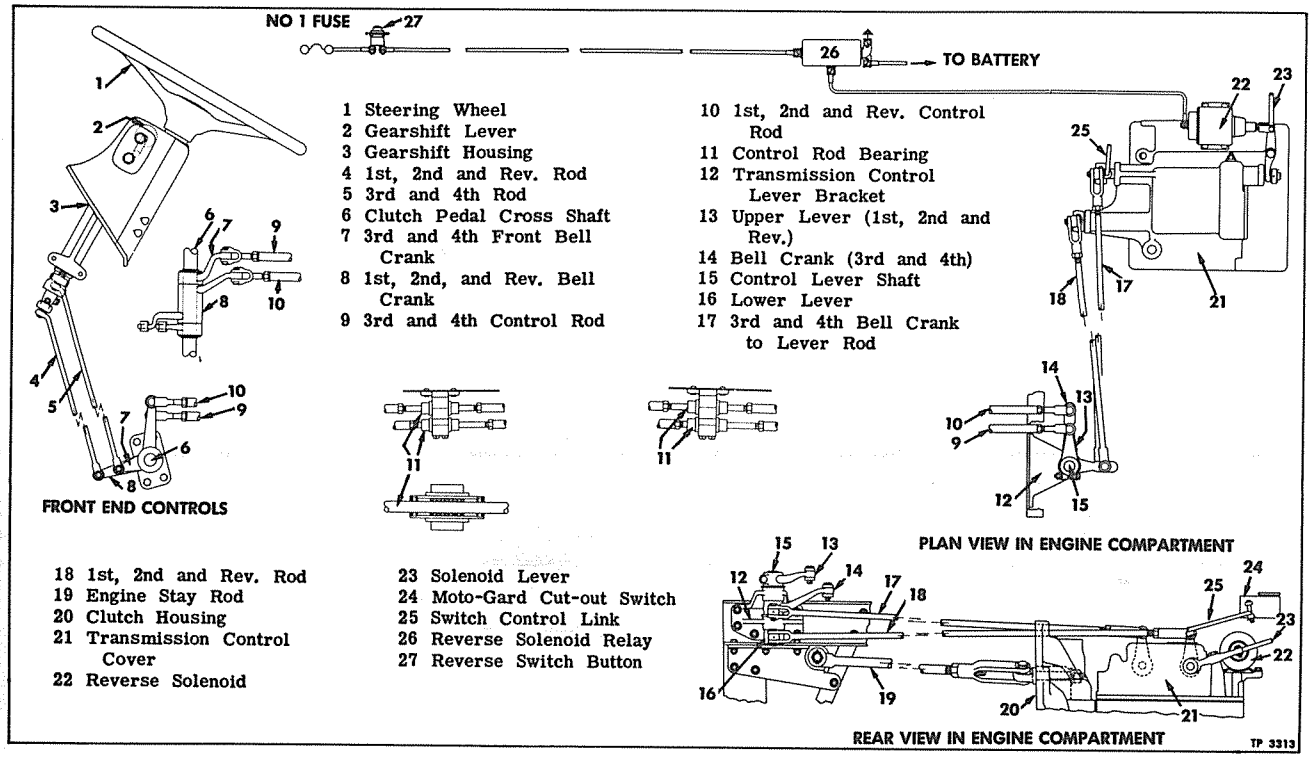


Figure 5—Transmission Controls and Linkage

countershaft (87) to countershaft 3rd speed gear (22) and through sliding clutch (18) and clutch gear (14) to mainshaft, through mainshaft to angle drive gears and output shaft (65).

FOURTH SPEED

The 3rd and 4th speed sliding clutch (18) is engaged with mating teeth at rear of main drive gear (2), and power flow is directly through sliding clutch (18) and clutch gear (14) to mainshaft and to angle drive gears and output shaft (65).

REVERSE SPEED

Reverse speed is shifted manually using same controls as forward speeds, but is assisted by a solenoid mounted on transmission shift cover and controlled by a button mounted on coach body at left of driver (fig. 5).

To shift from neutral into reverse speed, move gear shift lever into first speed position engaging first speed gears. Refer to figure 1. Energize solenoid on transmission by pressing reverse button. Solenoid moves shift finger in transmission cover from first and second speed fork to reverse speed fork. Move gear shift lever into second position which moves reverse shift fork forward disengaging sliding clutch on countershaft and engaging sliding clutch on reverse idler gears. Control button must be held in depressed position until shift into reverse is complete.

For reverse operation, sliding clutches are positioned and gears are meshed as shown in figure 2, and power flow is from main drive gear (2) to countershaft drive gear (101), through countershaft to 2nd speed gear (95), to reverse idler driven gear (96) and driving gear (92), to mainshaft 1st speed gear (39), through sliding clutch (32) to mainshaft, to angle drive gears and output shaft.

MAINTENANCE ON VEHICLE

The light maintenance operations covered in this paragraph include items which should be periodically inspected and those minor repairs and adjustments which may be accomplished without removing transmission from vehicle.

TRANSMISSION CONTROL ROD ADJUSTMENT

Provisions are made for adjustment of control rod length by use of adjustable yokes. When replacing transmission or any of the control linkage, be sure linkage is adjusted as follows, before attempting to operate vehicle:

1. Place gearshift lever in neutral position; then move transmission gears into neutral position by operating levers (25 and 37, fig. 1).

2. Adjust yokes on rods (17 and 18, fig. 5) so that clevis pins can be inserted without moving rods or levers from neutral position. Make certain

lock nuts are tightened after adjustment has been made.

INSPECTION AND LUBRICATION

At regular intervals inspect for looseness of transmission mounting bolts, also transmission cover retaining bolts. Inspect for evidence of lubricant leakage at bearing caps and at filler and drain plugs.

Refer to Lubrication (Sec. 13 of this manual) for recommendations on type and quantity of lubricant to use and also for recommended lubrication intervals.

A sump in lower position of main case is equipped with magnetic type drain plug. This plug should be removed and cleaned at draining periods. Angle drive case is also equipped with magnetic type plug which should be cleaned at regular periods. "Hot" and "Cold" levels shown on dip stick (fig. 6) refer to lubricant level when lubricant is hot or cold, respectively.

REVERSE SOLENOID RELAY ADJUSTMENT (Fig. 7)

If difficulty is experienced when shifting transmission into reverse, the trouble may lie in the relay or wiring. Engine control switch must be "on" to supply current to relay circuit. Check No. 1 fuse at instrument panel. If fuse is not burned out, trace circuit to engine compartment panel. Refer to Wiring (Sec. 7A of this manual) for wiring diagram.

When certain that current will flow to relay, check and adjust as follows:

1. Be sure wiring connections are clean and tight at each relay terminal.

2. Remove relay cover and examine points. If points are burned or pitted, disconnect wire from terminal marked "B" and dress points using a thin fine cut point file.

3. Measure point opening. Correct setting is .035 inch. If necessary to change point opening, bend stop as indicated in figure 7.

4. Measure air gap between armature and relay coil core. Air gap should be .012 inch with points closed. If necessary to change air gap, loosen air gap adjustment screws (fig. 7) and move armature up or down as required. If necessary, align support carrying lower contact so that air gap will be uniform between core and armature.

5. Install relay cover and attach any wires removed during adjustment.

REVERSE SOLENOID LINKAGE ADJUSTMENT

Whenever the reverse solenoid has been removed, or if difficulty is experienced when shifting transmission into reverse speed; the following procedure will properly adjust the solenoid linkage.

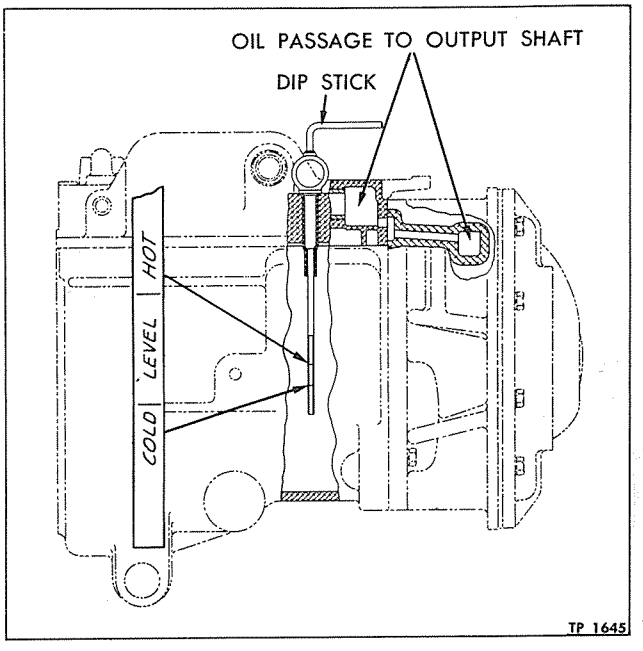


Figure 6—Check Lubricant on Dip Stick

1. Make certain transmission control rod linkage is correctly adjusted.

2. Place gear shift lever in first speed position.

3. Remove cover from rear of reverse solenoid, and inspect contact points. If points are burned or pitted, dress with a fine cut point file.

4. Manually shift reverse solenoid lever into reverse speed position.

5. Adjust lock nuts on solenoid link screw so that solenoid points just break, with the 1st, 2nd and reverse speed shift shaft moved fully into reverse speed position (fig. 8).

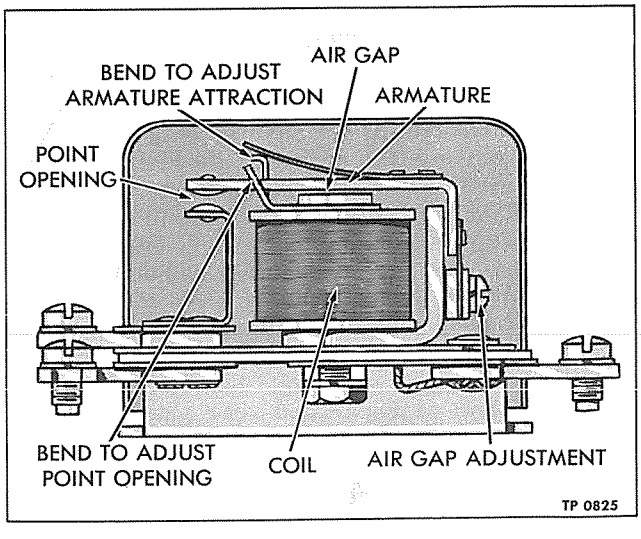
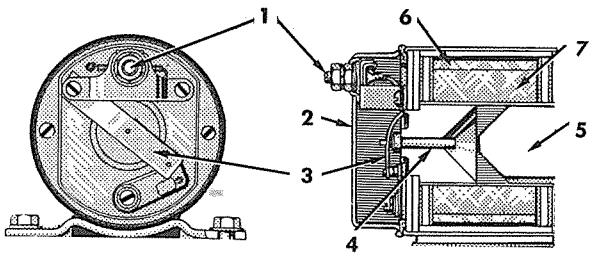
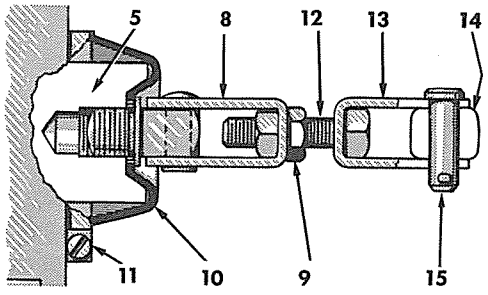


Figure 7—Reverse Solenoid Relay

TRANSMISSION



SECTIONAL VIEWS OF REVERSE SOLENOID



SOLENOID LINKAGE

1 Wire Terminal	6 Holding Coil	11 Clamp
2 Cover	7 Pulling Coil	12 Adjusting Bolt
3 Contact Points	8 Link Assembly	13 Clevis
4 Pin	9 Lock Nut	14 Lever
5 Plunger	10 Dust Shield	15 Clevis Pin

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Figure 8—Reverse Solenoid and Linkage

TRANSMISSION REPLACEMENT

TRANSMISSION REMOVAL

Transmission may be removed from vehicle as a unit without removing complete power plant as follows:

1. Remove dust pans from beneath engine and transmission, then place engine dolly under engine flywheel housing to relieve weight at power plant rear mountings

2. Disconnect clutch, hand brake, and transmission control rods from levers at transmission by removing clevis pins which attach rod yokes to levers.

3. Disconnect electrical wiring from reverse solenoid and speedometer sending unit. Also detach engine ground strap.

4. Break seal wire (fig. 9) and remove plate inclosing duo-speed governor cable connection at transmission cover. Back off guide (8), loosen eye-bolt nut which clamps cable to lever, then unscrew tube nut (9) to detach governor cable tube from transmission cover. Lift tube and cable assembly away from transmission.

5. Remove two bracket to insulator bolts at left-hand side of transmission case, and one bolt through insulator and channel, at right-hand side of transmission at bulkhead.

6. Remove bumper support to engine support channel brace, remove bolts attaching lower insulator to support channel, then remove strut to channel bolt at right-hand rear side of transmission. Remove bolt at top of strut and remove strut.

7. Disconnect engine stay bar by removing clevis pin at clutch housing eye bolt.

8. Place transmission dolly under transmission to take weight of the assembly, then remove bolts and cap screws attaching clutch housing to engine flywheel housing.

9. Loosen slip joint dust cap on propeller shaft so joint can be pulled apart as transmission is removed.

10. Move transmission assembly straight away from engine assembly, being careful to keep transmission drive gear aligned with clutch disc hub as transmission is withdrawn. Jack screws in threaded holes in clutch housing flange may be used to force the clutch housing away from engine flywheel housing.

CLEANING

After transmission is removed from vehicle, reverse solenoid and linkage should be removed. Exterior of transmission should be thoroughly cleaned with a suitable solvent to loosen and remove all accumulated road dirt and grime. After all dirt and other foreign material has been removed, rinse with gasoline and blow dry with compressed air. NOTE: The use of caustic cleaning compounds should be avoided due to their deleterious effect on aluminum.

TRANSMISSION INSTALLATION

Coat clutch shaft splines sparingly with lubricant as directed in Lubrication (Sec. 13 of this manual). Install clutch release parts in clutch housing if they have been removed. Refer to Clutch (Sec. 5 of this manual) for clutch release mechanism information.

1. If hand brake mechanism and propeller shaft universal joint have been removed from transmission, refer to respective sections (4D or 18, of this manual) for construction of these as-

semblies, and assemble on transmission.

2. Support transmission on dolly with drive gear perfectly aligned with clutch disc hub, then move transmission toward engine meanwhile guiding propeller shaft slip joint splines together.

3. Bolt clutch housing firmly against flywheel housing and remove transmission dolly.

4. Install support strut at right-hand rear corner of coach, and install support channel and insulator under transmission. Install bolt through insulator and channel at bulkhead and the two insulator bolts at rear left-hand side of transmission case. Install bumper support brace.

5. Connect engine stay bar (19, fig. 5) at clutch housing, then remove engine dolly. Connect clutch, hand brake, and transmission control rods to levers at transmission. Moto-Gard cut-out switch (24, fig. 5) must be connected to special clevis pin which holds 1st, 2nd, and reverse rod to lever on transmission.

6. Connect engine ground strap, electric speedometer wiring and reverse solenoid wire to respective units.

7. Adjust all control rods as directed in "Transmission Control Rod Adjustment" previously in this section. Also be sure to adjust clutch pedal free-travel to specified dimensions.

8. Remove plate enclosing duo-speed governor lever at transmission cover. Move governor control tube and cable into position with cable inserted through eye-bolt (7) in lever (fig. 9). Tighten tube nut into threads in transmission cover. Hold cable in exactly the same relationship to lever as it occupied before removal. If new cable is being installed, refer to "Duo-Speed Governor Adjustment" in Engine (Sec. 8B in this manual) for instructions on method of connecting cable to lever at transmission.

Be sure to tighten eye-bolt nut firmly and turn guide (8, fig. 9) in until inner end contacts cable, then tighten lock nut. After checking adjustment, the wire and seals must be installed as shown in figure 9.

9. Check lubricant level on dip stick (fig. 6) and if necessary add lubricant to "cold" level, referring to Lubrication (Sec. 13 of this manual) for lubricant specifications.

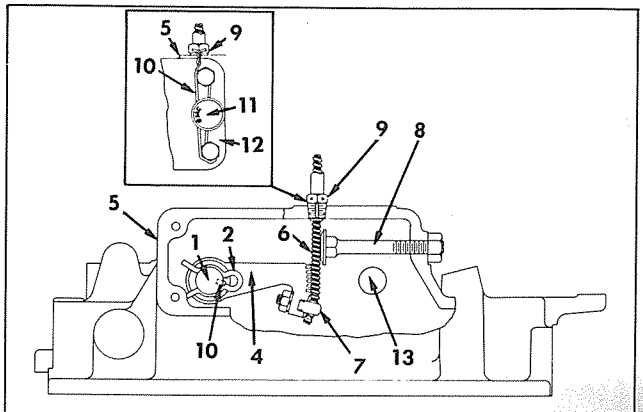
TRANSMISSION FORWARD CONTROLS

CONTROL REMOVAL AND DISASSEMBLY (Fig. 10)

Gearshift lever and control mechanism at driver's position may be removed from vehicle and disassembled as follows:

1. Remove steering wheel.

2. Remove cover (cap) from rearward side of gearshift housing (20); also, remove instrument



1 3rd and 4th Shift Shaft	7 Eye Bolt
2 Lock	8 Guide
3 Woodruff Key	9 Control Tube Nut
4 Governor Control Lever	10 Lock Wire
5 Transmission Cover	11 Seal
6 Control Cable	12 Cover
	13 1st, 2nd, and Reverse Shaft

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Figure 9—Duo-Speed Governor Control

panel mounting screws and move panels sufficiently to gain access to lower end of shift control assembly. Remove directional signal switch plate from side of housing (20) and disconnect wiring.

3. Remove nuts attaching rods (26 and 28) to levers (24 and 27), Remove bolts attaching housing (20) at instrument panel, and two bolts holding lower end of housing to body structure.

4. Lift housing and control assembly upward and remove from vehicle.

5. Remove clamp bolt from lever (27) and remove lever and key.

6. Remove clamp bolt from lever (24), then drive lever and bearing assembly off tube and shaft. Remove key from tube (29) and remove items 17, 18 and 19 from tube at lower end of housing.

7. Remove housing cap (3), poppet retainers (5) and poppets (6) from housing.

8. Loosen bolt in shaft upper lever (12). Remove snap ring (10), then drive shaft (2) downward to remove shaft. Keyway in shaft permits shaft to be driven downward past key in upper lever (12).

9. Remove gearshift lever (15) with collar (13) and bearing as an assembly, then remove upper lever (12).

10. Remove clamp bolt from lever (16), then drive tube upward to expose lever key. Remove key, then drive tube out through bottom of housing and remove lever (16) and items 17, 18, and 19 from housing.

11. If necessary to replace the needle bearing assemblies (7, 9, or 21) these assemblies

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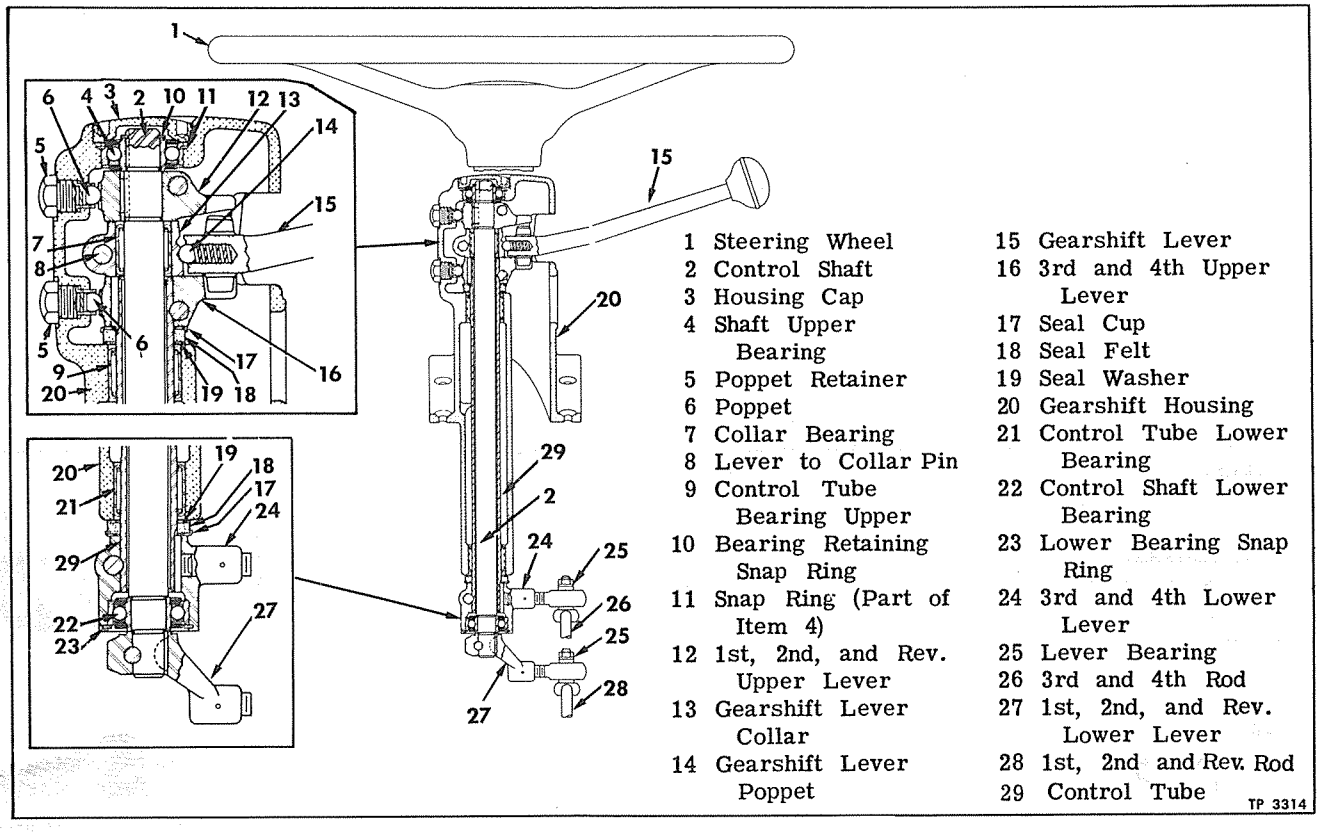

Figure 10—Sectional View of Transmission Controls at Steering Column

may be removed and new parts installed by using suitable driver to force out old bearings and install new ones.

12. To separate gearshift lever from collar (13), remove pin (8), Poppet (14) can then be removed for inspection. Bearing (22) may be removed from lever (24) after removing snap ring (23), and bearing (4) may be removed by pulling out through top of housing.

CONTROL ASSEMBLY AND INSTALLATION (Fig. 10)

Ball bearing assemblies (4 and 22) are permanently lubricated type requiring no additional lubrication during life of the bearing.

Assemble mechanism and install as follows:

1. Install bearing (22) in lever (24) and retain with snap ring (23).

2. Place spring and ball (poppet, 14) in gearshift lever and assemble lever (15) onto collar (13) by installing pin (8) through the two parts.

3. Insert tube (29) through needle bearings (9 and 21), assemble seal washer (19), felt (18) and cup (17) on upper end of tube, then drive key into keyway. Install upper lever (16) and retain with clamp bolt.

4. Hold upper lever (12) and gearshift lever and collar assembly inside housing, then insert shaft (2) upward through tube (29), needle bearing (7) and lever (12). Drive key into slot in shaft and keyway in lever (12).

5. Install bearing assembly (4) on upper end of shaft (2) and retain with snap ring (10). Install and tighten cap (3).

6. Assemble springs and balls (poppets) (6) and retainers (5) in housing.

7. Support housing assembly in inverted position and install washer (19), felt (18), and cup (17) over tube. Place key in keyway in tube, then drive lever (24) and bearing assembly onto tube and shaft. Install clamp bolt to retain lever (24). Bolt must engage notch in tube.

8. Install Woodruff key in keyway in lower end of shaft (2), then drive lever (27) onto shaft. Install clamp bolt through lever (27) - bolt must fit into notch in shaft. Tighten clamp bolt in upper lever (12).

9. Set housing and control assembly into place in vehicle. Be sure steering column grommet is in place and in good condition. Bolt housing into place at instrument panel, and install two mounting bolts at lower end of housing.

10. Connect rods (26 and 28) to respective levers, then check operation of gearshift lever.

11. Connect directional signal wiring and install switch plate on housing.

12. Install removeable cover over steering gear below instrument panel, and install housing cover (cap) on housing.

13. Install steering wheel.

ASSEMBLY REPAIR

Key numbers in text refer to figure 1, 2, and 4 except as indicated in text.

TRANSMISSION DISASSEMBLY
(Refer to Fig. 1)

Procedures for disassembling and assembling transmission as outlined in succeeding paragraphs should be followed carefully to accomplish overhaul of transmission with minimum effort and time. In addition to the tools, necessary receptacles for cleaning the parts and air pressure for blowing out particles of dirt should be available. Parts should be cleaned thoroughly for inspection and reassembly.

Mount unit rigidly on a suitable stand and proceed as follows:

1. Remove main case cover (24) with shift forks and shafts. Remove oil pump from rear of transmission.

2. Remove mainshaft rear bearing cap (70). Cap has two slots at outer edge so that screw driver may be used to pry cap from retainer (67). Do not use extreme force when prying cap. Note quantity of shims (74) used between cap (70) and retainer (67). Tag shims so that original pack may be used when reassembling.

3. Lock mainshaft by engaging both first and third speed gears.

4. Straighten out lips of lock washer (73) and remove mainshaft rear bearing nut (72) with special wrench (Tool No. CS 1075). This nut has left-hand threads and is marked with letters L.H. to distinguish it from countershaft nut.

5. Remove rear bearing retainer (67) with bearings. Retainer is provided with tapped holes in which puller screws may be used. Note quantity of shims (75) used between retainer and angle drive case cover (59). Tag shims so that original pack may be used when reassembling.

6. Remove angle drive case cover (59). Two dowel pins are used to locate angle drive case cover to angle drive case (58).

7. Remove angle drive case (58) with angle drive gear and shaft assembly (65) from main case (9).

8. Remove lock wire and stud nuts which attach clutch housing to transmission; then remove clutch housing, together with clutch release parts.

9. Tapped hole in rear end of reverse idler shaft is provided to withdraw shaft from case. As shaft is withdrawn, gears, bearings, spacers and thrust washers will be stripped from shaft.

10. Pull mainshaft bevel pinion (64) from mainshaft with special puller. (Tool No. CS 1048). Puller must grasp pinion firmly or pinion teeth will be damaged. Spacer (66) will be removed as pinion is pulled from mainshaft.

11. Remove mainshaft center bearing retainer (110) with bearing (42) and thrust washer (40). Retainer has slots on outer edge so that screw driver may be used to assist in its removal. Bearing and thrust washer may be pressed from retainer if necessary after removing bearing snap ring.

12. Remove main drive gear bearing cap (7) and oil seal (1).

13. Remove main drive gear (2) with bearing (5) and bearing retainer (8). Pry lightly between main drive gear and third and fourth speed sliding clutch (18) to start drive gear bearing retainer from case. Remove pilot bearing (11) from mainshaft.

14. Tie mainshaft gears together to hold them in place while removing mainshaft from case. Lift mainshaft and gears from case.

15. Straighten lips of lock washer (83) and remove countershaft rear bearing lock nuts (84 and 82).

16. Force countershaft (87) towards rear until rear bearing retainer flange is exposed, then pull rear bearing (85) and retainer (86) from countershaft.

17. Remove first speed gear (89) and thrust washer (88) from countershaft out through bearing hole in case.

18. Move countershaft towards rear until shaft clears front bearing (104), then remove countershaft with gears out through top of case.

DISASSEMBLY OF SUBASSEMBLIES

REMOVING MAINSHAFT GEARS

1. Untie gears and remove first speed gear (39), first and second speed sliding clutch (32) and third and fourth speed clutch (18).

2. Raise tangs on lock washers (13) and remove lock nut (12) from end of mainshaft.

3. Balance of gears with thrust washers, bearings and spacers may be stripped from mainshaft.

REMOVING GEARS FROM COUNTERSHAFT

1. Remove low speed gear sliding clutch (91).

2. Remove front bearing nut (106) and washer (105).

3. Remove front bearing inner race (104) and retaining washer (103). Bearing and outer race need not be removed unless bearing is to be replaced. In that event, use a suitable driver to remove bearing from case.

4. Drive gear (101), spacer (99) and third speed gear (97) may be pressed off countershaft.

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ANGLE DRIVE GEAR AND SHAFT (Fig. 1)

1. Remove propeller shaft flange nut (43) with special wrench, (Tool No. CS 1076).
2. Remove propeller shaft flange (44) with special puller, (Tool No. CS 1062).
3. Remove bearing cap (45) with oil seal (46). Slots are provided in cap so screw driver may be used to pry it off.
4. Remove bearing retainer (50) with special Puller, (Tool No. CS 1128), with outer bearing (48) and inner bearing cup (54). Tapped holes are provided in retainer so that puller screws may be used to remove it. Note quantity of shims (51) used between bearing retainer and angle drive case (58). Tag shims so that original pack may be used when reassembling. Also note quantity of shims (52) used between bearings (48 and 54). Tag these as well so that original pack may be used when reassembling.
5. Remove speedometer driven gear (56) and sleeve.
6. Remove bevel drive gear (65) from angle drive case.
7. Inner tapered bearing (54), speedometer drive gear (55), spacer (57) and straight bearing (60) may be stripped off shaft.
8. Bearing (60) outer race may be removed from case after snap ring (61) has been removed.

TRANSMISSION MAIN CASE COVER DISASSEMBLY (Refer to Fig. 4)

1. Remove shift rod end plate (6).
2. Remove shift fork clamp screws.
3. Remove shift rods (12, 4 and 7) from cover stripping off forks (20, 18, and 8) and stop sleeves (30, 31 and 14) as rods are removed.
4. Remove plug (1) from cover (13) and strike cover sharply on block of wood to remove interlock pins (3 and 5).
5. Remove lock from groove in 3rd and 4th shift shaft (10), then pull duo-speed governor lever (fig. 9) off end of shaft, and remove Woodruff key.
6. Remove clamp screws from third and fourth speed shift finger (9), drive finger over to expose Woodruff key and remove key. Shaft (10) with lever (12) may then be removed from cover.
7. Remove pin (24) from first, second, and reverse shaft (17) and remove collar (25).
8. Remove clamp screw from first, second and reverse shift finger (19).
9. Remove shaft (17) with lever (15) from cover, stripping off reverse spring (28) washers (27 and 29) and finger (19). Finger is held to shaft with key.
10. Solenoid shift lever (23) may be removed from cover by removing lever screw (22).
11. Guide (fig. 9) may be removed from cover after lock nut has been removed.

CLEANING AND INSPECTION

Clean all parts carefully in gasoline or suitable cleaning fluid and blow dry with compressed air.

All bearings should be cleaned thoroughly. After bearing assemblies have been soaked in cleaning fluid, tap them sharply on a block of wood to dislodge any solid particles. Slush them again in cleaning fluid and blow dry with air. Do not spin the bearings with the air - revolve them slowly in races with fingers as air is directed at right angles to the balls or rollers. Examine races and bearings for pits and scores, then oil each assembly thoroughly with clean engine oil.

Individual needle bearing rollers which were removed from main shaft gears should be thoroughly washed and inspected. Replace those bearing rollers which show signs of scores or pits (There are 138 rollers to each gear).

Examine teeth on all gears carefully for nicks and worn spots. Do not take chances with gears which are appreciably nicked or scored. Small nicks may be carefully removed with a "slip-stone" or hone.

Clean interior of main case thoroughly. Remove magnetic drain plug and clean all particles of metal from magnet. Blow out all oil passages with compressed air.

TRANSMISSION CASES AND DOWEL PINS

Clutch housing and transmission angle drive case are held in proper alignment with transmission main case by dowel pins (fig. 11). Two dowels (3) are used at front of main case and two (4) are used at rear of the main case. Angle drive case cover (6) which supports mainshaft rear bearing is also dowelled onto angle drive case.

In the original assembly the transmission serial number appearing on main case name plate is also stamped on angle drive case and cover. It is of utmost importance when assembling transmission that transmission cases are not interchanged with corresponding parts from other transmission. ALWAYS MATCH CASES BY REFERRING TO SERIAL NUMBER.

SERVICE INFORMATION

Transmission main cases, angle drive cases and covers and clutch housings furnished for replacement are standard production parts. Oversize dowel pins are available and must be used to overcome any possible misalignment of dowel pin holes when a new transmission main case, angle drive case, cover, or clutch housing is being assembled with original parts or vice versa.

Before installing oversize dowel pins, it will be necessary to enlarge and ream existing holes with parts bolted together in correct relationship.

MAIN CASE TO ANGLE DRIVE CASE OVERSIZE DOWEL INSTALLATION

Accomplish the following operations when a new angle drive case is to be installed on original main case or vice versa.

1. Install mainshaft center bearing retainer in counterbore at rear of main case. With angle drive case attaching studs in place, place angle drive case on main case and install stud nuts. Tighten stud nuts evenly and firmly to draw the cases together. Mainshaft center bearing retainer will act as a pilot to assure correct position of angle drive case on main case.

2. Using a drill slightly smaller than oversize dowel pin diameter, enlarge the dowel pin holes. Then ream dowel pin holes to size given in "Specifications" at end of this section.

3. Remove stud nuts and separate the two cases; then add counterbore in angle drive case to accommodate oversize dowel pin snap rings (8, fig. 11).

4. Press or drive oversize dowel pins into holes in main case with snap rings contacting surface of case.

ANGLE DRIVE CASE COVER INSTALLATION (Fig. 1)

Accomplish the following operations in the event that new angle drive case is to be installed with original angle drive case cover or vice versa. Perform operations which follow with transmission drive gear and mainshaft installed in main case and the angle drive case assembled on main case.

1. Press mainshaft rear bearings (68 and 69) into retainer (67) then bolt bearing and retainer assembly and cap (70) onto angle drive case cover.

2. Install angle drive case cover on angle drive case, guiding rear bearing over rear end of mainshaft to locate cover on case. Strike angle drive case cover with soft faced hammer to seat cover against angle drive case then install stud nuts finger tight. Rotate mainshaft to insure positive alignment of cover with mainshaft, then tighten cover retaining nuts.

3. Using a drill slightly smaller than standard dowel pin diameter (Refer to "Specifications)" drill new dowel pin holes through pin boss in cover and into angle drive case to depth of at least 1 inch, being careful to avoid original holes.

4. Line ream new holes to .6525 to .6550 inch then remove cover and enlarge holes in cover to .6565 to .6570 inch.

5. Remove angle drive case cover and press or drive oversize dowel pins into new holes in angle drive case.

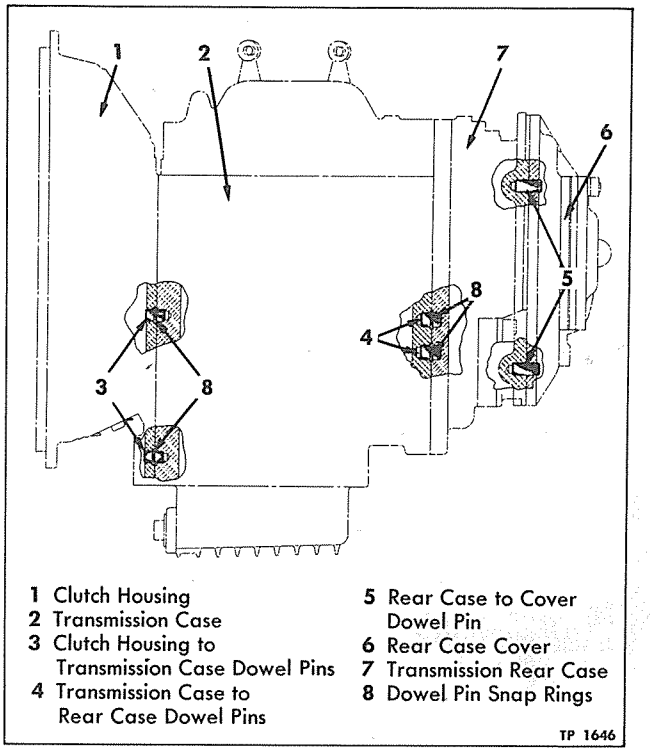

Figure 11—Transmission Case Dowel Pins

CLUTCH HOUSING (Fig. 1)

If clutch housing is replaced with new part, ream dowel pin holes in new part to size in "Specifications" at end of this group, using bearing cap (7) installed on main case as a pilot for locating clutch housing.

TRANSMISSION SUBASSEMBLY BUILD-UP

Procedures as outlined in following paragraphs should be followed in order to assemble transmission with minimum time and effort.

ASSEMBLING COUNTERSHAFT & GEARS (Fig. 1)

Proceed to assemble transmission as outlined in following paragraphs.

1. Press third speed countershaft gear (97) on shaft. Make certain that both keys are in position and key ways are free from burrs.

2. Place spacer (99) and keys (100) in position and press drive gear (101) into place.

3. Install drive gear retaining washer (103) with recessed edge towards bearing (104).

4. Install front bearing inner race (104), retaining washer (105) and nut (106). Tighten nut securely and install cotter pin.

5. Install front bearing (104) into case if it has been removed.

6. Install sliding clutch (91) over countershaft

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clutch gear (94). Do not install first speed gear (89) at this time.

MAINSHAFT AND DRIVE GEAR ASSEMBLY (Fig. 1)

1. Place mainshaft in vise with rear end of shaft down (vise should be equipped with "soft" jaws).
2. Make sure second speed gear (30) is thoroughly clean especially on inside diameter then apply a coat of heavy gear oil. Place gear over mainshaft in position shown in figure 1.
3. Install 69 roller bearings (28) in hub of gear. Install bearing spacer (29) and push bearings and spacer in position. Then install top row of roller bearings.
4. Install third speed gear thrust collar (27) and install third speed gear (22) and bearings (20) in same manner as second speed gear. There are 69 roller bearings used in each row.
5. Install third and fourth speed clutch gear (14) over splines of main shaft. Install sliding clutch (18) over gear (14).
6. Install washer (13) and retaining nut (12) and tighten firmly.
7. Lock nut with lock washer.
8. Reverse position of shaft in vise and install first and second speed sliding clutch (32).
9. Install first gear (39) over mainshaft, inserting roller bearings (36) and spacer (38) in same manner as second and third speed gears.
10. Remove mainshaft with gears from vise.
11. Coat inner face of thrust washer (40) with grease and place in position. Grease will prevent washer from sliding out of place when assembly is lowered into case and in that manner prevent bearings from falling out when shaft is tilted for installation. It is also a good plan to temporarily wire the two large gears together to hold them in place while installing shaft.
12. Press bearing (5) into retainer (6), then install the assembly on main drive gear (2).
13. Install lock washer (4) and nut (3). Tighten nut securely and bend tangs of lock washer over flats of nut.

OIL PUMP (Fig. 1)

Oil pump may be readily assembled in following manner:

1. Insert hexagonal drive shaft (80) in end of countershaft (87).
2. Install gasket and oil pump housing (81) over studs and drive shaft (80).
3. Install drive gear (79) in housing (81), with drive bushing end of gear over drive shaft (80).
4. Press driven gear shaft (76) into cover (78) if it has been removed.
5. Assemble driven gear (77) over shaft (76).
6. Fill cover and housing with lubricant and assemble cover with gasket to housing.
7. Install nuts with lock washers and tighten securely.
8. Fill pressure relief valve hole with lubricant and rotate drive shaft (80) in proper direction while filling until all passages are filled with lubricant, and air is displaced. Unless oil pump is filled with lubricant, it may not pick up when first started, thereby changes of damage to transmission through lack of lubricant are increased.
9. Install pressure relief valve ball (109) spring (108) and plug (107).
10. Lock plug with lockwire.

ANGLE DRIVE GEAR AND SHAFT (Fig. 1)

1. Install drive gear straight roller bearing (60) on shaft. Be sure bearings seats firmly against gear.
2. Install spacer (57), speedometer drive gear (55), inner tapered roller bearing cone (54), spacer (53) and original shim pack (52).
3. Install bearing cups (54 and 48) in retainer (50). Be sure cups are firmly seated against shoulder of retainer.
4. Place retainer (50) with bearing cups over inner tapered bearing cone (54) and install outer tapered bearing cone (48).
5. Install propeller shaft flange (44) and nut. Tighten nut securely.
6. Correct bearing adjustment will allow retainer (50) to turn freely but not spin. Increase or decrease shim pack (52), between bearing cones, as necessary to provide correct bearing adjustment.
7. Remove nut (43), propeller shaft flange (44) and retainer (50) with outer bearing (48). Protect shim pack (52) so it will not be disturbed until assembled in case.
8. Install straight roller bearing outer race (60) and snap ring (61) in angle drive case if they have been removed.
9. Place bevel gear and shaft (65) in position in angle drive case (58) and install retainer (50) with original shim pack (51) and outer bearing (48). Do not install bearing cap (45).
10. Install propeller shaft flange (44) and tighten nut (43) securely.

TRANSMISSION MAIN CASE COVER

(Key numbers refer to figure 4, except as noted).

1. Install first, second, and reverse shaft (17) and lever (15) into cover (13), assembling shift finger key, shift finger (19), finger clamp screw washer (29), reverse lock-out spring (28) and washer (27) as shaft is moved into position. Refer to figure 4 for position and relation of parts.
2. Install solenoid shift lever collar (25), and pin (24) in end of shaft.
3. Install third and fourth speed shift shaft (10) and lever (12) into cover and assemble finger

key, shift finger (9) and clamp screw.

4. If guide (8, fig. 9) has been removed from cover install same as shown.

5. Drive Woodruff key into slot in end of shifter shaft (10) then install duo-speed governor lever and retain with lock installed in groove (fig. 9).

6. Insert third and fourth speed rod poppet spring, plunger and poppet in cover (13). Third and fourth rod is upper rod in figure 4, or right-hand rod when transmission is installed in vehicle and may be identified by three poppet notches closely spaced with recesses for fork clamp screws nearer poppet notches.

7. Insert 3rd and 4th speed rod (7) into cover (13) assembling spacer (14) and fork (8) as shown in figure 4, as rod is moved into position.

8. Install fork clamp screws and tighten securely.

9. Shift 3rd and 4th speed rod into neutral, install interlock pin (5) moving it down to rod (7).

10. Insert 1st and 2nd speed rod poppet spring, plunger and poppet in cover (13). First and 2nd rod is center rod and may be identified by three poppet notches closely spaced with recesses for fork clamp screws farther away from poppet notches.

11. Insert 1st and 2nd rod (4) into cover assembling fork (18) and spacer (31) as shown in figure 4 as rod is moved into position.

12. Install fork clamp screw and tighten securely.

13. Shift 1st and 2nd speed rod into neutral, install interlock pin (3) and move it down to rod (4).

14. Insert reverse rod poppet spring, plunger and poppet into cover. Reverse rod is bottom or left-hand rod and may be identified by having only two poppet notches.

15. Insert reverse rod (2) into cover assembling fork (20) and spacer (30), as shown in figure 4, as rod is moved into position.

16. Install fork clamp screw and tighten securely.

17. Install interlock pin plug (1) in cover.

18. Install shift rod end cover gasket and cover (6).

TRANSMISSION ASSEMBLY

Accomplish operations which follow in sequence given, referring to figures 1, 2, & 4 for position of parts.

COUNTERSHAFT INSTALLATION

1. Place countershaft and gear assembly into case, tilt front end upward and lower rear end into case, inserting rear end through rear bearing hole in case far enough to permit front end to be inserted into front bearing (104).

2. Install first speed gear (89) on countershaft by inserting gear through rear bearing hole in case.

3. Install thrust washer (88), recessed edge towards bearing (85).

4. Press rear bearing (85), into retainer (86). Be sure retainer dowel pin is in place, then install bearing and retainer, being careful to align notch in retainer with dowel pin in case.

5. Install inner lock nut (84) and tighten securely.

6. Install lock washer (83) and outer nut (82). Tighten nut and lock both nuts by bending lips of washer over flats of nuts.

REVERSE IDLER GEAR INSTALLATION

Refer to figure 2 and note position and width of spacers installed, at ends and in between roller bearings. Install reverse idler shaft in following manner:

1. Drive shaft into case just far enough to install thrust washer, driven gear, bearings and spacers. Make sure that oil passages in shaft are clean and that plug in end of shaft is in place.

2. As shaft is driven into case, install remaining parts. Front thrust washer fits in notch in case.

3. After shaft is driven into case, tongue on outer end of shaft must be in vertical position, to register with recess in angle drive case.

MAINSHAFT AND MAIN DRIVE GEAR INSTALLATION

1. Tilt front end of mainshaft and gears assembly upward and lower rear end into transmission case and out through center bearing hole in case.

2. Place pilot bearing (11) on front end of mainshaft.

3. Using a new gasket (112) under retainer flange, install main drive gear and bearing assembly in case. Holes through retainer flange must be aligned with tapped holes in case. Also, be sure gasket does not obstruct oil return passage.

4. Install new oil seal (1) in main drive gear bearing cap (7) and replace cap using same thickness of shims (8) as was removed at disassembly. NOTE: Outer race of bearing (5) must be held tight by bearing cap (7). The thickness of shims (8) should be .002 inch less than space existing between bearing cap (7) and retainer flange when measured with a feeler gauge.

5. Insert main drive gear (2) and bearing (5) assembly into place and while working main drive gear bearing retainer into case, hold mainshaft in alignment so that pilot bearing (11) will enter pocket of main drive gear. In order to facilitate assembly of main drive gear, one person should hold mainshaft in alignment, while other is in-

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stalling drive gear and bearing.

6. Remove thrust washer (30) at rear end of mainshaft and install center bearing retainer (110). NOTE: This bearing retainer is located on case with one dowel driven into case. Dowel fits in a milled recess in retainer. The other slots or recesses in retainer are for the purpose of removing part.

7. Reinstall thrust washer (40), recessed edge towards bearings, and press center bearing (42) into place.

8. Install bevel pinion spacer (62) over rear end of mainshaft. Spacer is available in three sizes. See "Specifications" at end of this section.

9. Replace bevel pinion keys (63) and install bevel pinion (64).

ANGLE DRIVE (Fig. 1)

1. Angle drive case (58) is held to main case (9) by studs. Cases are located and held in alignment by dowel pins held in place by snap rings. Install new gasket and assemble angle drive case, with bevel gear and shaft, to main case. Make sure that pinion (64) and gear (65) teeth are matched as marked, that dowel pins are in place and that milled end of reverse idler shaft fits into milled slot in case. NOTE: In the event new angle drive case or main case is being installed, ream dowel pin holes in new part to size shown in "Specifications" at end of this section.

ANGLE DRIVE CASE COVER (Fig. 1)

1. Install angle drive case cover (59) using new gasket. Be sure dowel pins are in place. Draw studs up evenly and securely. NOTE: Be sure dowel pins are in good condition.

MAINSHAFT REAR BEARING (Fig. 1)

Mainshaft Rear Bearing Adjustment (Fig. 1)

Correct adjustment of mainshaft rear bearing is obtained in following manner:

1. With bearing retainer (67) removed from transmission, install bearings (68 and 69) and cups in retainer.

2. Assemble bearing cap (70) with original shims (74). Attach cap to retainer with suitable bolts.

3. Increase or decrease shims (74) between cap (70) and retainer (67) until retainer will turn freely on bearings but will not spin.

4. Disassemble and protect shims selected for use at reassembly.

Installing Mainshaft Rear Bearing

1. Install mainshaft rear bearing spacer (66).

2. Install rear bearing retainer (67) with inner bearing cup. Do not install shims (75) between retainer and angle drive case cover (59).

3. Install bearing cones (68 and 69), lock washer (73) and nut (72). Draw nut up tightly.

4. Install puller screws in tapped holes in retainer (67).

5. While holding inner rear bearing (68) tight against its cup, adjust puller screws in retainer (67 until mainshaft and countershaft gears line up).

6. Measure space between retainer (67) and cover (59) with feeler gauge and select proper thickness of shims (75). If this thickness becomes greater than .035 inch, remove pinion (64) and replace spacer (62) with one of sufficient thickness to bring shim pack thickness to less than .030 inch.

7. Remove retainer (67) and reassemble, installing shims selected.

8. Install outer bearing cup (69) and cap (70) using shims (74) between cap and retainer as previously determined when bearing adjustment was made.

9. Check alignment of gears again.

ANGLE DRIVE GEAR BACKLASH (Figs. 1 and 12)

1. With transmission completely assembled with the exception of shims (51) between drive gear outer bearing retainer (50) and angle drive case (58) also bearing cap (45) not assembled, install puller screws in bearing retainer (50) and adjust backlash to dimensions shown on gears. If backlash dimensions on gears are not legible, adjust to .008 - .010 inch. See backlash sketch in bottom corner of figure 12.

2. Measure space between retainer (50) and angle drive case (58) with feeler gauge.

3. Select proper shim thickness and install shims, assembling retainer (50), bearing (48) cap (45) with new oil seal (46), flange (44) and nut (43).

4. Tighten flange nut (43) and cap stud nuts (47) securely.

5. Check backlash in gears again and correct if necessary by adding or removing shims (51).

ANGLE DRIVE GEARS TOOTH CONTACT (Figs. 1 and 12)

1. To check for proper tooth contact paint several teeth on pinion (64) with ground red lead mixed with a few drops of engine oil. Rotate mainshaft by hand in same direction as when operating in forward speed, applying tension at propeller shaft flange at same time. Gears may be seen through filler hole in top of angle drive case (58).

2. Tooth contact impression should start at toe of tooth and extend back about 80% of tooth length toward heel on drive side of tooth. Contact should be distributed evenly over flank and face of tooth, indicating center of contact on pitch line. Refer to diagrams "A" and "B" in figure 12.

3. If tooth contact is too far out on tooth (diagram "C" figure 12), reduce shim thickness

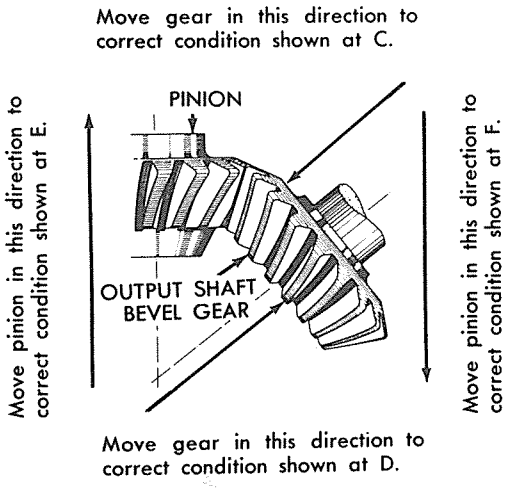
INSTRUCTIONS

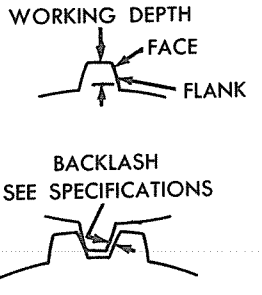
1—Install mainshaft and angle drive output shaft assemblies; then adjust pinion and bevel gear for proper backlash as directed in "Adjustments" paragraph of this section.

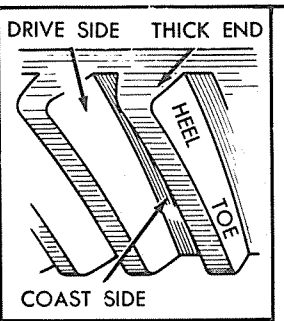
2—Paint three of four teeth of bevel gear on output shaft with red lead or mechanics' blue and rotate pinion until bevel gear makes complete revolution.

3—Note area of tooth contact which should start at toe and extend about 80 percent of tooth length toward heel, as at B.

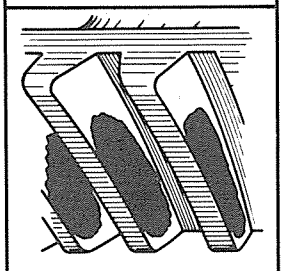
4—Vary position of pinion and gear as per chart until proper tooth contact is obtained. Be sure that sufficient backlash has been allowed so that gear can be completely revolved without any highspots being felt.



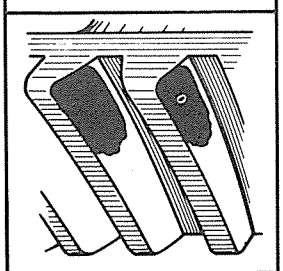




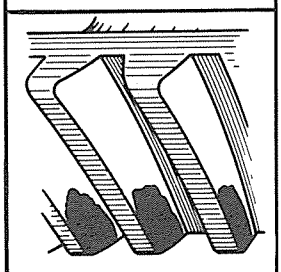
A—Check adjustments at drive side of bevel gear tooth.



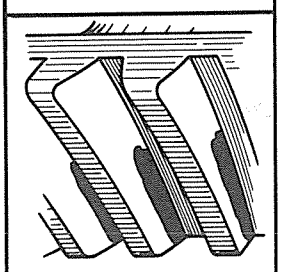
B—Shows correct tooth contact.



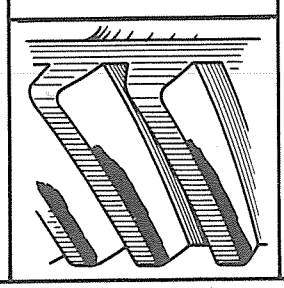
C—Shows short contact at heel. To correct, move gear toward pinion. Then move pinion away from gear to again secure correct backlash.



D—Shows short contact at toe. To correct, move gear away from pinion. Then move pinion toward gear to again secure correct backlash.



E—Shows heavy contact on flank or lower portion of tooth. To correct, move pinion away from gear until contact comes to full working depth of gear tooth without breaking contact at flank. Then move gear toward pinion to secure correct backlash.



F—Shows heavy contact on face or upper portion of tooth. To correct, move pinion toward gear until contact covers flank of tooth without breaking contact at face. Then move gear away from pinion to secure correct backlash.

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Figure 12—Angle Drive Gear Tooth Contact Chart

at (51) between bearing retainer (50) and angle drive case (58) moving gear (65) towards pinion (64). Restore backlash by adding shims at (75) between bearing retainer (67) and angle drive case cover (59).

4. If tooth contact extends back from toe appreciably less than 80% of tooth length (diagram "D" figure 12), move gear (65) away from pinion (64) by adding shims at (51). Restore backlash by reducing shims at (75).

5. If contact is low on flank of tooth (see diagram "E" figure 12) move pinion (64) away from gear (65) by reducing shims at (75). Restore backlash by adding shims at (51).

6. If contact is high on face of tooth (diagram "F" figure 12), move pinion (64) towards gear (65) by adding shims at (75). Restore back lash by reducing shims at (51).

OIL PUMP INSTALLATION

1. Using new oil pump gasket, install pump assembly on transmission, guiding drive shaft (80) into socket at rear of countershaft (87).

TRANSMISSION COVER INSTALLATION

1. Place levers (25 and 37) in neutral and move clutches (18, 32, 91 and 93) to neutral position.

2. With new cover gasket in place, lower cover assembly onto transmission case so that forks enter grooves in clutches.

3. Bolt cover in place. Install reverse solenoid assembly and lever (fig. 8) on transmission cover, and adjust solenoid linkage.

SPECIAL TOOLS

Reference is made to special tools and their use is illustrated in this section. These tools, or their equivalent, are necessary and are recommended to more readily and efficiently accomplish certain service operations. The tools, however, are not supplied by the coach manufacturer. Names and addresses of vendors or manufacturers are shown as a reference, and since such vendors are the suppliers of these tools, information regarding availability, price, etc., should be obtained directly from them.

Tool No.	Name
CS-1075	Mainshaft Rear Bearing Nut Wrench
CS-1048	Bevel Pinion Puller
CS-1076	Flange Nut Wrench
CS-1062	Flange Puller
CS-1128	Bearing Retainer Puller

Vendor's Name	Address
Curtiss & Smith Mfg. Corp.	Pottstown, Pennsylvania

SPECIFICATIONS

SPICER MODEL NUMBERS ..... 7141 and 7141-A

Speeds ..... Four Forward - One Reverse
Mounting ..... Unit
Gear Selection ..... Manual, Remote Control

GEAR RATIOS

Spicer Model	7141-A	7141
Angle Drive Gears	1.00 to 1	1 to 1
First Speed	3.86 to 1	4.36 to 1
Second Speed	2.50 to 1	2.84 to 1
Third Speed	1.50 to 1	1.70 to 1
Fourth Speed (Direct)	1.00 to 1	1 to 1
Reverse	3.29 to 1	3.72 to 1

GEAR BACKLASH

Angle Drive Gears	0.008" - 0.010"
Mainshaft and Countershaft Gears	0.006" - 0.008"
Sliding Clutches and Clutch Gears	0.004" - 0.007"
Oil Pump Gears	0.006" - 0.008"

MAINSHAFT GEAR BEARING ROLLERS

Number of rollers Per Gear	138
Length	0.655" - 0.675"
Lapped Diameter	0.12500" - 0.12525"

BEARING ADJUSTMENTS

Angle Drive Gear Tapered Bearing
- See Instructions

SHIM THICKNESS AVAILABLE

Main Drive Gear Bearing Cap	0.003" - 0.010"
Mainshaft Rear Bearing Retainer	0.010" - 0.031"
Mainshaft Rear Bearing Cap	0.003" - 0.010"
Angle Drive Gear Bearing Cone	0.003" - 0.010" - 0.030"
Angle Drive Gear Bearing Retainer	0.003" - 0.010" - 0.031"

SPACER THICKNESS

Bevel Pinion - Front (Available in 3 Sizes)	0.230" - 0.245" - 0.260"
Bevel Pinion - Rear	0.938" - 0.948"
Angle Drive Gear Bearing Cone	0.373" - 0.377"

THRUST WASHER THICKNESS

Mainshaft 1st Speed Gear	0.262" - 0.266"
Countershaft 1st Speed Gear	0.245" - 0.249"
Reverse Gear - Front	0.182" - 0.187"
Reverse Gear - Rear	0.185" - 0.186"

COUNTERSHAFT 1ST SPEED GEAR BUSHING

Inside Diameter (As Serviced)	2.346" - 2.349"
Inside Diameter (in Place) Grind to	2.3595" - 2.3605"

OIL PUMP GEARS

Width ..... 0.622" - 0.623"

OIL PUMP DRIVE GEAR SHOULDER

Outside Diameter ..... 0.8725" - 9.8755"

OIL PUMP DRIVE GEAR SHOULDER BORE IN COVER AND HOUSING

Inside Diameter ..... 0.8745" - 0.8755"

OIL PUMP DRIVEN GEAR BUSHING

Length	0.610" - 0.620"
Burnish to	0.4990" - 0.5005"
Bushing to Shaft Clearance	0.001" - 0.0035"

PRESSURE RELIEF VALVE SPRING

Free Length	2-7/16"
Pressure @ 2"	3 lbs. 6-1/2 oz.
	3 lbs. 9-1/2 oz.

REVERSE SHIFT LOCK SPRING

Free Length	5-1/16"
Lbs. Pressure @ 1-3/4	38 - 42

SERVICE DOWEL PINS AND HOLES

Clutch Housing to Main Case	
Pin Diameter	0.8110" - 0.8120"
Hole Diameter in Both Pieces	0.8070" - 0.8095"
Main Case to Angle Drive Case	
Pin Diameter	0.8110" - 0.8120"
Hole in Both Pieces	0.8070" - 0.8095"
Angle Drive Case to Angle Drive Case Cover	
Pin Diameter	0.6555" - 0.6560"
Hole Diameter in Angle Drive Case	0.6525" - 0.6550"
Hole Diameter in Angle Drive Case Cover	0.6565" - 0.6570"

TRANSMISSION

SERVICE BULLETINS

Service Bulletins are issued, whenever required, supplementing information in this section. The information contained in these bulletins should be noted in the text and bulletin filed for future reference — Make note of bulletin number in spaces below:

NOTES

Propeller Shaft

Contents of This Section

Related Subjects in Other Sections

Propeller shaft used on vehicle covered in this manual (fig. 1) is solid type. The specific shaft assembly used together with service data, is listed under "Specifications" later in this section. Propeller shaft is equipped with heavy duty needle bearing universal joints.

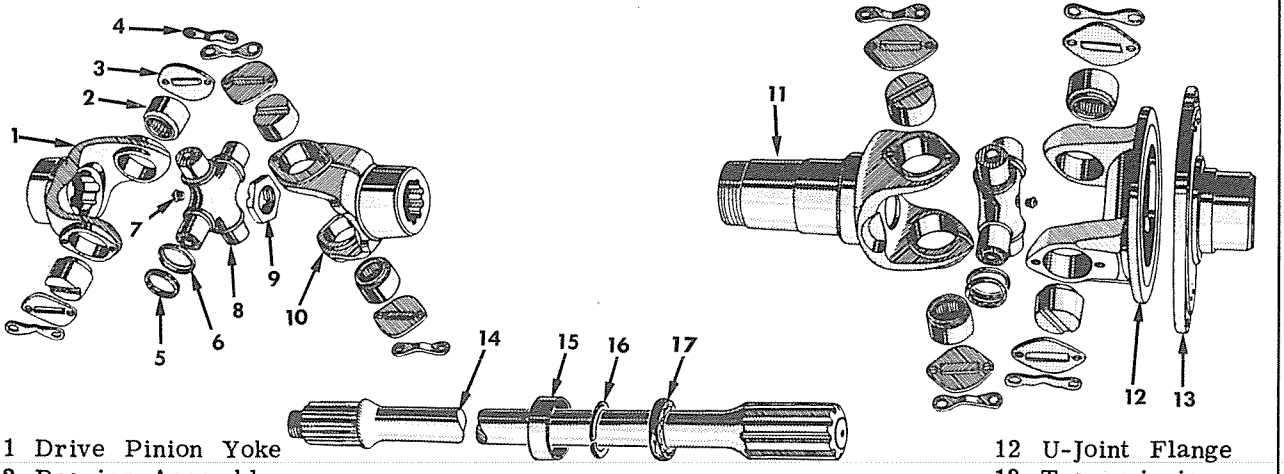
Flange yoke, at slip joint end is bolted to transmission companion flange.

Flange yoke is fixed joint end, is bolted to companion flange at differential.

The shaft is splined to slip yoke and retained in place, by a steel dust cap which screws onto slip yoke. The fixed end of shaft assembly is also splined into yoke and retained in yoke with washer, nut and cotter pin.

Slip joint, at transmission end of shaft, compensates for variations in distance between transmission and differential.

These variations are brought about by the rise and fall of rear axle as the vehicle passes over rough pavement, or uneven terrain. Slip joint also facilitates removal of transmission or power plant.



1 Drive Pinion Yoke
2 Bearing Assembly
3 Bearing Cap
4 Cap Lockstrap
5 Gasket
6 Gasket Retainer
7 Relief Valve
8 Trunnion
9 Shaft Nut
10 Fixed End Yoke
11 Slip Yoke
12 U-Joint Flange
13 Transmission Flange
14 Propeller Shaft
15 Dust Cap
16 Steel Washer
17 Cork Washer

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Figure 1—Component Parts of Propeller Shaft

PROPELLER SHAFT

PROPELLER SHAFT REMOVAL

Whenever it is necessary to remove propeller shaft assembly for repair purposes, when transmission and rear axle are in place, removal may be accomplished in the following manner.

1. Remove lock wires, nuts and lock washers that attach propeller shaft companion flanges to companion flanges of transmission and differential.
2. Disassemble slip joint. NOTE: Read instructions given later under "Joint Removal" in this section, before disassembling slip joint.
3. After slip joint has been disassembled, propeller shaft can be removed from vehicle by pulling slip joint end of shaft out through engine access door and by pulling fixed joint end of shaft toward rear axle.

PROPELLER SHAFT DISASSEMBLY

JOINT REMOVAL

Slip yoke and fixed end yoke are marked with aligning arrows when shaft is manufactured and assembled. Before slip joint or fixed joint are removed from shaft, ascertain that arrows on yokes are clear and discernible (fig. 2).

If arrows are not visible, mark both yokes distinctly; then remove dust cap on slip joint. Slip joint can now be removed from shaft. To remove fixed joint from shaft, disassemble universal joint in manner later described under "Universal Joint Disassembly" in this section; then remove cotter pin, nut and washer which secure fixed yoke on shaft.

UNIVERSAL JOINT DISASSEMBLY (Fig. 1 and 4)

1. Remove cotter pins which secure lock straps in place and remove lock straps; then remove cap screws and bearing caps. Drive needle bearing assemblies out of yokes with a flat faced brass drift 1/32 inch smaller in diameter than bearing.

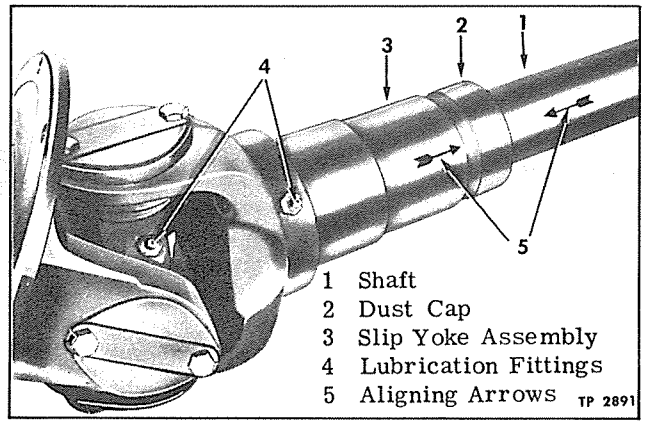


Figure 2—Propeller Shaft With Slip Joint Installed

Place drift on top of bearing and tap drift with a hammer until opposite bearing is out of place. Reposition joint assembly and repeat procedure until all bearings are removed. CAUTION: To prevent damage to bearings, do not permit bearing assemblies to drop on the floor.

2. Slide trunnion side way as far as possible then tilt trunnion until journal clears hole in yoke and remove trunnion from yoke.
3. Remove gaskets and retainers from trunnion journals. Remove lubrication fittings and pressure relief fitting from trunnion.

CLEANING AND INSPECTION

PROPELLER SHAFT

Thoroughly clean splines of shaft, then inspect for wear. See "Specifications" at end of this section.

If shaft is badly warped or broken, it should be replaced. Welding of broken shafts is not recommended since this operation requires special facilities.

SLIP AND FIXED JOINT YOKES

Carefully inspect each yoke for cracks, wear, damage or bent condition. Small burrs or rough spots can usually be removed with a hone. See "Specifications" later in this section, for clearance between shaft and yoke splines. Replace if defective or badly worn. Check expansion plug in slip joint; make certain small lubrication relief hole is open and clean.

UNIVERSAL JOINT

Clean all parts with clean gasoline or other suitable cleaning fluid. Thoroughly clean all lubricant passages in trunnion (fig. 4), lubrication fitting and pressure relief valve. Soak needle bearing assemblies in cleaner to soften particles of lubricant. Clean bearing assemblies using stiff brush, then blow out dirt with compressed air. CAUTION: Be sure bearing assemblies are absolutely clean; even very small particles of dirt or grit can cause excessive bearing wear. Needle type bearing assemblies should not be disassembled.

Inspect journal bearing surfaces for roughness or needle bearing grooves. If grooves and roughness will not clean up with moderate honing, trunnion and bearing assemblies should be replaced. Carefully inspect each bearing assembly for wear or missing bearings, see "Specifications" at end of this section. Excessive wear is indicated if needles drop out of retainer, or if journal bearing surface shows marks of needles. If such conditions exist, needle bearing assemblies should be replaced

After needle bearing assemblies are thoroughly cleaned, work a small quantity of lubricant recom-

mended in Lubrication (Sec. 13 of this manual) into each needle bearing assembly; then place bearings on trunnion journals and check for excessive wear. Refer to "Specifications" at end of this section for limits. If excessive clearance is noted, install new parts as required. Otherwise pack each bearing one third full with lubricant recommended in Lubrication (Sec. 13 of this manual). Inspect gaskets and gasket retainers and replace if not in good condition.

PROPELLER SHAFT REASSEMBLY

UNIVERSAL JOINT ASSEMBLY (Fig. 1)

1. Install pressure relief valve and lubrication fitting in trunnion, next, install gasket retainers and new gaskets on journals.

2. Insert one journal of trunnion into yoke as far as possible from inside, and tilt until opposite journal clears yoke and drops into position.

IMPORTANT: When installing trunnion in yoke at differential end of shaft, position pressure relief valve side of trunnion toward shaft.

3. Before fixed joint at differential end of propeller shaft is assembled, install yoke onto shaft and ascertain that mark on shoulder of shaft aligns with arrow on yoke with yoke in position. Install washer over threaded end of shaft and secure washer in place with nut. Tighten nut firmly; then align slots in nut with cotter pin hole in shaft and install new cotter pin full size of hole.

4. Insert bearing assemblies from outside of yoke and tap into place with rawhide hammer. WARNING: Do not use steel hammer for this purpose.

5. Care should be exercised to assure that joints move freely in the bearings and do not bind. If joints are tight, change the bearings around until joints are free and operate smoothly in the assembled position.

6. Place bearing caps on yokes and install cap screws. Tighten cap screws firmly; then install lock straps over heads of cap screws and secure lock straps in place with new cotter pins full size of holes.

PROPELLER SHAFT INSTALLATION

1. Install slip joint assembly on transmission companion flange, install bolts, new internal tooth lock washers; then tighten bolts alternately and firmly. Insert lock wire through bolts so that if bolts loosen, wire will be drawn tighter. Draw wire taut and secure ends together. Mark alignment arrows with light colored chalk to assist in installation of shaft assembly.

2. Install dust cap, cork washer and steel washer, on slip joint end of shaft (fig. 3). When

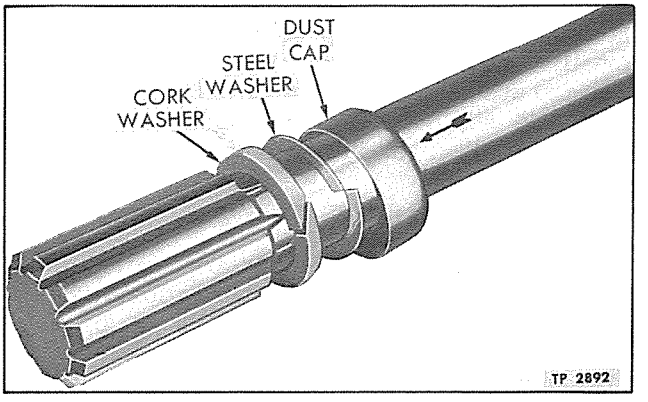


Figure 3—Propeller Shaft With Slip Joint Removed

two steel washers are used. cork washer should be installed in between steel washers.

3. Apply a thin coating of lubricant recommended in Lubrication (Sec. 13 in this manual), on propeller shaft splines slip end. Place shaft assembly in position under vehicle and align arrows on both universal joints; then insert splined end of shaft into slip joint.

4. Position fixed joint on differential companion flange, then install bolts, new lock washers, nuts and new lock wire. Bolts through differential companion flange should be positioned so that nuts will lock against boss on hand brake drum. Install lock wire as previously described in step (1).

5. Position cork and steel washer and screw dust cap onto slip joint, then tighten dust cap

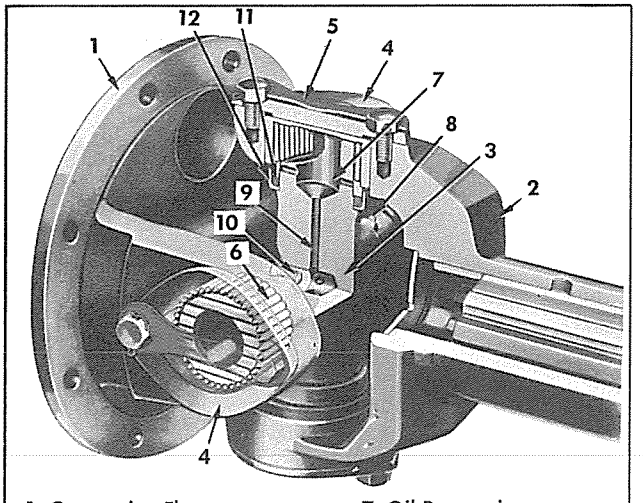


Figure 4—Cross Section View of Universal Joint

hand tight. CAUTION: DO NOT USE WRENCH. Check all nuts, bolts, cap screws, etc., on entire propeller shaft assembly to ascertain that all parts are assembled properly. Lubricate universal joints and slip joint with lubricant specified in Lubrication (Sec. 13 in this manual).

LUBRICATION

Trunnion of universal joints are drilled and provided with pressure gun lubrication fittings, through which the lubricant travels to all four reservoirs (fig. 4) and then through a small hole in the side of each reservoir, direct to the needle bearing assemblies. A pressure relief valve is installed in the central chamber (fig. 4) which prevents damage to the gaskets when extremely high pressure is used in forcing in the lubricant. This valve also serves as an indicator to show when joints are completely filled with lubricant.

Needle bearings are well protected against lubricant leakage and the ingress of foreign matter by the gaskets provided.

Splines of slip joint are lubricated through pressure gun lubrication fitting installed in slip yoke assembly.

Universal joints and slip yoke splines should be lubricated periodically as specified in Lubrication (Sec. 13 in this manual).

SPECIFICATIONS
(New Limits)

Universal Joint Type	Slip Joint 1701 Series	Fixed Joint 1708 Series
Shaft Diameter	2.4975"-1.4980"	1.993"-1.998"
Trunnion Journal Diameter	1.3201"-1.3206"	1.3201"-1.3206"
Number of Rollers	36	36
Diameter of Rollers	.12475"-.12500"	.12475"-.12500"
Length of Rollers	.920"-.925"	.920"-.925"
Yoke Groove Width	.3885"-.3900"	.3105"-.3120"
Shaft Spline Thickness	.3860"-.3875"	.3120"-.3135"
Clearance Between Shaft Splines and Yoke Splines	.001"-.004" Loose	.000"-.003" Tight

Hubs and Bearings

Contents of This Section

Related Subjects in Other Sections

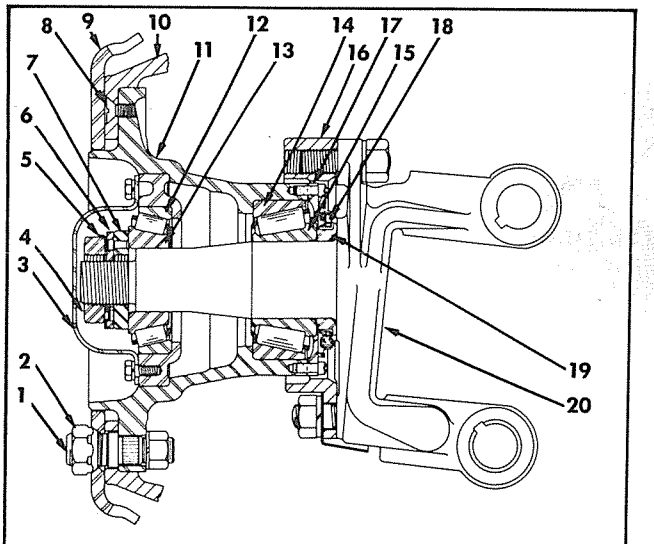
Wheels and hubs are carried on two opposed tapered roller bearings as shown in figures 1 and 2. Bearings are adjustable for wear and their satisfactory operation and long life depend upon proper adjustment and correct lubrication. If bearing adjustment is too tight, bearings will overheat and wear rapidly. Loose adjustment will result in pounding, and will also contribute to steering difficulties, uneven tire wear, and inefficient brakes. Before checking or adjusting wheel bearings, always be sure brakes are fully released and do not drag. Wheel studs are installed in hub flange as shown in figures 1 and 2. Brake drums are mounted over wheel studs on outer side of hub flange and attached to hub with countersunk screws.

BEARING ADJUSTMENT

Wheel bearing adjustment should be checked carefully at each inspection period. Jack up wheels one at a time and check bearing play by using a pry bar under tires. Observe movement of brake drum in relation to brake spider or shoes. If bearings are adjusted correctly, movement of drum will be just noticeable and wheel will turn freely with no drag. If test indicates that adjustment is necessary make adjustments as follows:

FRONT WHEEL BEARINGS (Fig. 1)

1. Remove cap screws and hub cap from hub.
2. Raise lip of nut lock and remove lock nut, nut lock, and lock ring from spindle.
3. Tighten adjusting nut unitl wheel binds, at the same time rotating wheel to make sure all surfaces are in proper contact.
4. Back off adjusting nut 1/6 turn, or more if necessary, making sure that wheel turns freely.



1 Wheel Stud	12 Outer Bearing Cup
2 Wheel Nut	13 Outer Bearing Cone and Roller Assy.
3 Hub Cap	14 Inner Bearing Cup
4 Lock Nut	15 Inner Bearing Cone and Roller Assy.
5 Nut Lock	16 Brake Spider
6 Lock Ring	17 Oil Seal Wiper
7 Adjusting Nut	18 Oil Seal Assy.
8 Brake Drum Screw	19 Bearing Spacer
9 Wheel	20 Steering Knuckle
10 Brake Drum	
11 Hub	

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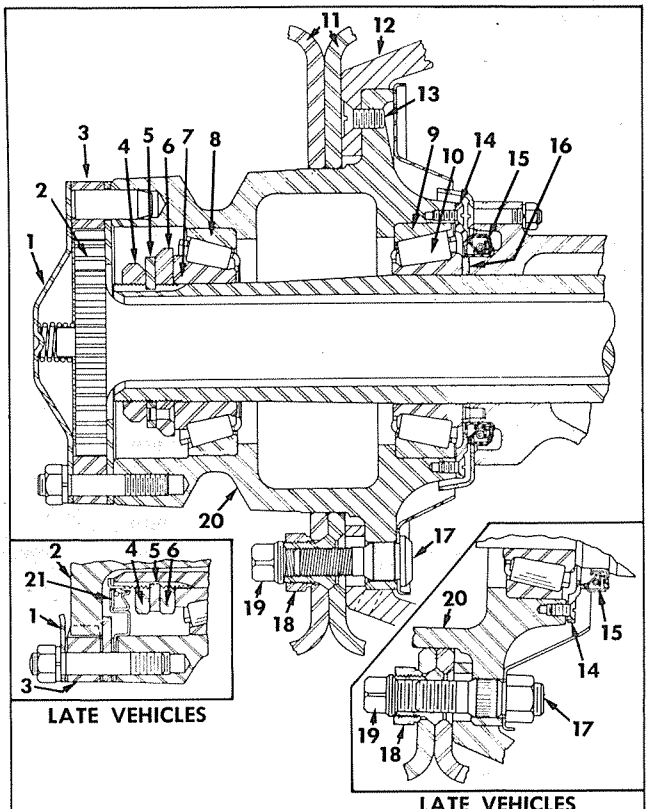
Figure 1—Front Hub and Bearings

5. Replace lock ring with dowel pin in adjusting nut inserted in hole in ring. Either side of ring may be used toward adjusting nut, whichever requires the least change in position of adjusting nut to permit assembly.

HUBS AND BEARINGS



1 Drive Plate Cover	11 Wheels
2 Axle Shaft	12 Brake Drum
3 Drive Plate	13 Brake Drum Screw
4 Lock Nut	14 Oil Seal Wiper
5 Lock Ring	15 Oil Seal Assy.
6 Adjusting Nut	16 Inner Bearing Washer
7 Outer Bearing Cone and Roller Assy.	17 Wheel Stud
8 Outer Bearing Cup	18 Outer Wheel Nut
9 Inner Bearing Cup	19 Inner Wheel Nut
10 Inner Bearing Cone and Roller Assy.	20 Hub
	21 Outer Oil Seal Assy.

Figure 2—Rear Hub and Bearings

6. Install nut lock and lock nut on spindle and draw nut up tight.

7. Recheck bearing adjustment, then bend lip of nut lock down against flat of lock nut. Install hub cap on hub, using new gasket between cap and hub.

REAR WHEEL BEARINGS (Fig. 2)

1. Remove axle shaft as directed in Rear Axle (Sec. 2 of this manual). On vehicles equipped with outer oil seal, remove seal.

2. Remove lock nut and lock ring from axle housing tube. On late type, unscrewing lock nut will force outer oil seal wiper and cork assembly off housing tube.

3. Tighten adjusting nut until wheel binds, at the same time rotating wheel to make sure all surfaces are in proper contact.

4. Back off adjusting nut 1/6 turn, or more if necessary, to make sure wheel turns freely.

5. Install lock ring with dowel pin in adjusting nut inserted in hole in ring. Either side of ring may be used toward adjusting nut, whichever requires the least change in position of adjusting nut to permit assembly.

6. Install lock nut and tighten firmly, then recheck bearing adjustment.

7. On late type, install oil seal wiper and cork assembly on end of housing tube. Make sure wiper fits squarely against end of tube and that the surface against which oil seal lip bears is not distorted. Coat lip of outer oil seal and oil seal wiper with grease, then install oil seal using new gasket between oil seal retainer and hub. Make sure oil seal lip is properly positioned on wiper.

8. Install axle shaft as directed in Rear Axle (Sec. 2 of this manual).

OIL SEALS

Front and rear hubs have oil seals at inner end to prevent leakage of wheel bearing lubricant into brake drum. Inner oil seals also prevent water and dirt from entering the hubs and contaminating the wheel bearing lubricant. Late vehicles also have oil seals at outer ends of hubs to prevent rear axle differential lubricant from entering the hubs and mixing with the wheel bearing lubricant.

Inner seals used in both front and rear hubs are stationary, end face, spring loaded type. Front seals are mounted on bearing spacer on steering knuckle spindle. Rear seals are mounted on shoulder on axle housing. Synthetic sealing surface of seals wipe on oil seal wipers which are attached to inner end of each hub with screws.

Outer seals used in rear hubs on late vehicles are spring loaded lip type seals with integral retainers which fit over axle shaft drive ring studs. Oil seal lip wipes on oil seal wiper which is pressed onto outer end of axle housing tube. Wiper to tube cork gasket is cemented to inner side of wiper.

At regular inspection periods, examine all seals carefully. If there is any indication of wear, deterioration, or damage at the sealing surface, a complete new seal assembly should be installed. Also examine surface of oil seal wipers against which seals bear. Any nicks, scratches, or rough spots on this surface will impair efficiency of seal.

Always spread a thin coating of grease on face of seal and on oil seal wiper before installing on hub.

FRONT HUB AND BEARING REMOVAL (Fig. 1)

1. Raise front end of vehicle until tires just clear floor.
2. Remove wheel stud nuts and remove wheel, then remove brake drum retaining screws and remove brake drum. Remove hub cap.
3. Raise lip of nut lock and remove lock nut, nut lock, lock ring, and adjusting nut from spindle.
4. Pull hub assembly straight off spindle, being careful not to permit outer bearing to fall out.
5. Remove screws attaching oil seal wiper to hub and remove wiper and gasket.
6. Lift inner bearing out of hub.
7. Perform cleaning and inspection operations outlined under "Cleaning and Inspection" later in this section. If inspection indicates the need of replacing oil seal or bearing cups, they may be removed as follows:
8. To remove oil seal, pry it off from bearing spacer on spindle. Bearing cups may be driven out, using a long brass drift through opposite side of hub.

REAR HUB AND BEARING REMOVAL (Fig. 2)

1. Raise rear end of vehicle until tires are just clear of floor.
2. Remove wheel stud nuts and remove wheels, then remove brake drum.
3. Remove axle shaft as directed in Rear Axle (Sec. 2 of this manual). On late type, remove outer oil seal and gasket.
4. Remove lock nut, lock ring, and bearing adjusting nut from axle housing tube. On late type, removing lock nut will force outer oil seal wiper and cork assembly off housing tube.
5. Pull hub assembly straight off axle housing tube.
6. Remove screws attaching oil seal wiper to hub and remove wiper and gasket.
7. Lift inner bearing out of hub.
8. Perform cleaning and inspection operations outlined under "Cleaning and Inspection" later in this section. If inspection indicates the need of replacing inner oil seal or bearing cups, they may be removed as follows:
9. To remove oil seal, pry it off the shoulder on axle housing. Bearing cups may be driven out, using a long brass drift through opposite side of hub.

CLEANING AND INSPECTION

CLEANING

1. Immerse bearing cone and roller assemblies in gasoline or other suitable cleaning fluid. Clean with stiff brush to remove old lubricant. Blow bearings dry with compressed air, directing air stream across bearing. Do not spin bearings while blowing them dry.
2. Thoroughly clean all old lubricant out of inside of hub and wipe dry. Make sure all particles of gasket are removed from inner end of hub.
3. Clean lubricant off axle housing tube (rear) or spindle (front). Wipe lubricant off oil seals, using a clean cloth dampened with cleaning fluid. Do not permit cleaning fluid or grease to get on brake linings.
4. Wash all small parts such as bearing nuts, lock rings, and oil seal wipers in cleaning fluid and wipe dry.

INSPECTION

1. Inspect bearing rollers for excessive wear, chipped edges, or other damage. Slowly roll rollers around cone to detect any flat or rough spots on cone or rollers. Replace bearing assemblies if any part is damaged.
2. Examine bearing cups in hub. If cups are pitted or cracked, they must be replaced with new parts.
3. Carefully examine oil seals for signs of wear, deterioration, distortion, or damage at the sealing surfaces. Replace oil seal assembly if any of the above conditions are evident.
4. Inspect oil seal wipers for nicks or rough spots which would cause rapid wear of seals. Replace with new parts as necessary.
5. After inspection is completed and parts replaced as necessary, lubricate bearings and inside of hub as directed in Lubrication (Sec. 13 of this manual).

FRONT HUB AND BEARING INSTALLATION (Fig. 1)

1. If bearing cups were removed, drive or press new cups into hub with wide side of cups toward inside. Make sure cups are fully seated against shoulder in hub and are not cocked. Make sure bearings and inside of hub are lubricated as directed in Lubrication (Sec. 13 of this manual).
2. If oil seal was removed, drive new oil seal assembly onto bearing spacer. Use extreme care when driving oil seal into place not to distort the seal flange. Make sure seal is seated squarely against shoulder on bearing spacer.
3. Place inner bearing cone and roller assembly in hub, then install oil seal wiper on inner end of hub, using new gasket. Draw wiper retaining screws up evenly and firmly.
4. Coat face of oil seal and oil seal wiper with grease.
5. Install hub assembly on spindle, then place

HUBS AND BEARINGS

outer bearing cone and roller assembly on spindle and push into hub with fingers. Install bearing adjusting nut and draw up finger-tight.

6. Install brake drum and retaining screws, then install wheel as directed in Wheels and Tires (Sec. 19B of this manual).

7. Adjust wheel bearings and complete the installation as previously directed under "Bearing Adjustment" in this section.

REAR HUB AND BEARING INSTALLATION (Fig. 2)

1. If bearing cups were removed, drive or press new cups into hub with wide side of cups toward inside. Make sure cups are fully seated against shoulder in hub and are not cocked. Make sure bearings and inside of hub are lubricated as directed in Lubrication (Sec. 13 of this manual).

2. If inner oil seal was removed, drive new oil seal assembly onto shoulder on axle housing. Use extreme care when driving oil seal into place not to distort the seal flange. Make sure inner bearing washer is in place on axle housing tube and that seal is seated squarely against shoulder on housing.

3. Place inner bearing cone and roller assembly in hub, then install oil seal wiper on inner end of hub, using new gasket. Draw wiper retaining screws up evenly and firmly.

4. Coat face of oil seal and oil seal wiper with grease.

5. Install hub assembly on axle housing tube, then place outer bearing cone and roller assembly on tube and push into hub with fingers. Install adjusting nut and draw up finger-tight.

6. Install brake drum on hub and install retaining screws, then install wheels as directed in Wheels and Tires (Sec. 19B of this manual).

7. Adjust wheel bearings and complete the installation as previously directed under "Bearing Adjustment" in this section.

SPECIAL TOOLS

The following special tools are not supplied by the Coach manufacturer. Name and address of vendor is given as a reference, and information regarding availability, price, etc., should be obtained directly from them.

Tool No.	Tool Name
CS-1109	Front Wheel Bearing Nut Wrench - Outer
CS-1109-A	Front Wheel Bearing Nut Wrench - Inner
CS-1061-A	Rear Wheel Bearing Nut Wrench - Outer (Early Vehicles)
CS-1061	Rear Wheel Bearing Nut Wrench - Inner (Early Vehicles)
CS-1417	Rear Wheel Bearing Nut Wrench - Inner and Outer (Late Vehicles)

Vendor	Address
Curtiss & Smith Mfg. Co.	Pottstown, Pennsylvania

Wheels and Tires

Contents of This Section

Related Subjects in Other Sections

WHEEL MAINTENANCE

Wheel studs and nuts on left side of vehicle all have left-hand threads. Studs and nuts on right side all have right-hand threads. Wheel stud nuts should be inspected and tightened at periodic intervals. Wheel maintenance will be considerably reduced by adherence to following procedure.

1. Before new vehicle goes into service and after each wheel removal, all wheel nuts should be thoroughly tightened. See that nuts are free from grease and oil. Do not use oil on studs or nuts.
2. To tighten nuts on dual rear wheels, loosen outer nuts, then tighten inner nuts. Tighten opposite nuts alternately so that wheel will be square against hub flange. After tightening inner nuts, tighten outer nuts.
3. Re-tighten nuts daily for first 500 miles to offset setting-in of clamping surfaces.
4. Inspect wheel nuts at least every 1,000 miles thereafter. (If vehicle is subjected to severe service, this inspection should be made daily regardless of the mileage).
5. When changing wheels or tires and before assembling wheels to hubs, remove dirt, grease, and excess paint from the mating surfaces.

WHEEL MOUNTING

Dual wheels should be mounted as shown in figure 1. Care should be exercised in positioning tire valves and wheel spokes. By placing spoke openings as shown, access to both outer and inner tire valves may be more readily obtained.

TIRE MAINTENANCE

One of the most important factors of economical and safe motor vehicle operation is systematic and correct tire maintenance. The tires must not only support the weight of the loaded vehicle, but they are also integral parts of the transmission and braking systems. Therefore, the tires should receive careful, systematic, and regular maintenance as do other operating units. The three major causes of tire trouble are (1) under-inflation, (2) bruises, and (3) misalignment. Tires should be checked periodically for these conditions.

INFLATION OF TIRES

Under-inflation is the greatest cause for loss of tire life expectancy. Tires should be checked frequently for this condition. The fabric, rubber, bead, contour, and size of tires used on these vehicles are designed to obtain maximum length of service under all operating conditions to which vehicles may be subjected. TIRES ARE DESIGNED

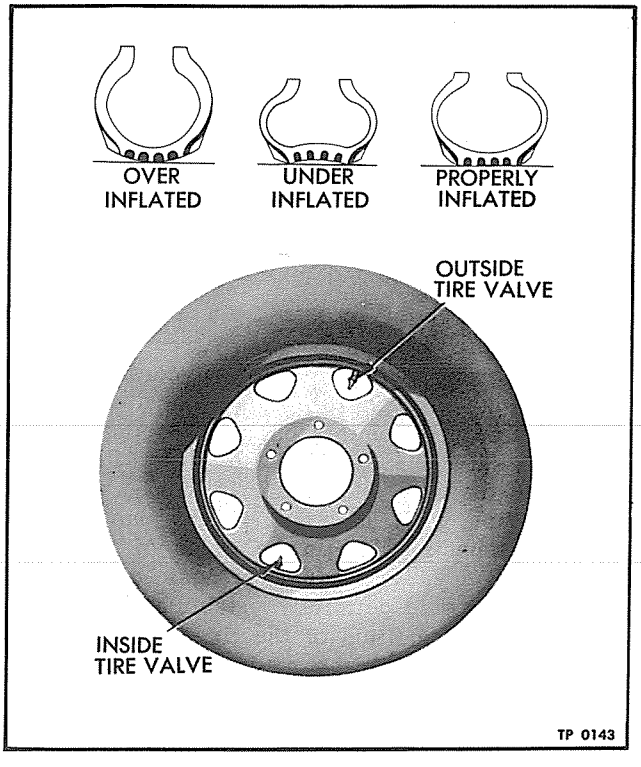


Figure 1—Tire Inflation and Dual Wheel Tire Valve Location

WHEELS AND TIRES

TO OPERATE EFFICIENTLY ONLY ON A PRESCRIBED AMOUNT OF AIR. Unless the correct air pressure is consistently maintained, the tires will not function as they should; consequently, safe, economical operation of the vehicle will be materially affected.

The operating air pressure recommended by the tire manufacturer is as essential to the safe and economical operation of the tire as the proper amount of oil would be to the engine or other chassis units.

An under-inflated tire runs sluggishly, heats up quickly because of the greater flexing, and is subjected to more frequent bruising. On the other hand, over-inflation may weaken the tire causing a blow-out. In addition to the deteriorating effect improperly inflated tires may have on the tire life, this condition will affect steering, riding comfort, and safe driving. FOLLOW THE TIRE PRESSURE RECOMMENDATIONS OF THE TIRE MANUFACTURER. Figure 1 shows sectional views of properly and improperly inflated tires.

BALANCED INFLATION

The whole efficiency of the vehicle will be upset if air pressures in the tires are out of balance. Balanced inflation may be expressed as -- all tires on the same axle should always carry the same pressure. A difference in air pressure of the rear tires and front tires may be permissible within certain limitations; however, there should not be a difference in pressures between the right and left tires on the same axle. A five pound under-inflation in one front tire not only can destroy ease of steering but creates steering hazards which generally point to a potential accident. An under-inflated rear tire can destroy the value of the most efficient brakes. Balance the tires for ease of steering, comfort in riding, safety in driving, as well as for minimum fuel consumption and maxiumum tire mileage.

PRESSURE LOSS

At periodic intervals, each tire should be gauged for pressure loss with an accurate gauge before tires are brought to correct operating pressure. The purpose of this check is to determine exact pressure losses in each tire. In other words, if at the time this check is made, a definite pressure loss is noted in any one of the tires, an inspection should be made of the tire showing the loss and cause of loss corrected. This method should definitely establish a "danger signal" on the condition of the tires. The pressure loss check should be made consistently with the same gauge, so that any element of inaccuracy in the gauge will be the same for all tires.

ROTATION OF TIRES

Tires should be interchanged at regular intervals to obtain maximum life. Change wheels without dismounting tires so direction of rotation will be reversed. The following system of interchanging is suggested: Right front to left rear inside or right rear outside. Left front to right rear inside or left rear outside.

If the inside tires show more wear than the outside dual tires, place front tires on inside when changing. In this case, outside dual tires can be interchanged between right- and left-hand side of vehicle.

If the outside dual tires show more wear than the inside dual tires, place front tires on outside when changing. At the same time, interchange right- and left-hand inside duals.

New tires should be installed on front wheels where they run coolest.

TIRE VALVES

The valve core is a spring loaded check valve in the valve stem, permitting inflation or defaltion of the tube. This check valve, or core, is not intended to hold the air during operation. The valve cap is provided to seal the air in the tube. When valve cap is tightened down on stem the sealing washer inside cap is pressed tightly against top of stem, preventing air leakage. It is important, therefore, that valve caps be used.

TIRE REMOVAL

To remove tire from rim, first remove wheel from hub then proceed as follows:

1. Deflate tire by removing valve core.
2. Insert screw driver between rim and split lock ring. Pry ring over edge of rim.
3. Remove lock ring and side ring as a unit.
4. Remove tire and tube.

TIRE INSTALLATION

1. NOTE: When installing synthetic tubes, coat both sides of the flap, the inner diameter of the tube, and the inside of the tire beads with a solution of neutral vegetable oil soap. Use a brush or cloth swab to apply the solution. Do not allow the solution to run down into the tire. This treatment aids tube in shaping itself during inflation without undue stretching in the rim and bead region.
2. Place tube in casing and inflate just enough to remove wrinkles. Place tire on rim with valve stem in slot in rim.
3. Install side ring and lock ring assembly. Make sure lock ring is fully seated.
4. Inflate tube slowly to about 10 pounds pressure, then again make sure that lock ring is fully seated. Turn wheel and tire assembly so that lock ring is away from person inflating tire, then reach through hole in wheel to apply air hose chuck to valve stem and inflate to correct pressure. Deflate tire by removing valve core, reinstall valve core, and reinflate to correct pressure.

Trouble Shooting

Contents of This Section

The information contained in this section includes a list of trouble symptoms which might be encountered. In addition, probable causes and remedies are briefly listed. No attempt is made in this section to outline detailed repair instructions, as these instructions are included in the various sections of the Maintenance Manual (see Index at front of manual).

The causes of trouble symptoms in any automotive vehicle may be varied; therefore, a hit-and-miss search would result in a tedious guessing contest. A proper diagnosis of symptoms is an orderly process of eliminating the causes of the symptoms. An "orderly process" means to check the most probable or common cause first, then proceed with the next cause.

Additional publications covering units used in these vehicles are as follows:

Unit	Form No.
Diesel Engine	X-4517

When any trouble is encountered in these units always refer to the applicable publication.

The following procedures are grouped to permit a practical diagnosis of trouble symptoms. In many instances, a symptom indicating trouble in one unit may be caused by a difficulty in a closely related unit or system.

ELECTRICAL SYSTEM TROUBLE SHOOTING

This paragraph includes those symptons which may occur in the starting system, battery, generator, regulator and lighting system. In addition to the information given on these pages, also refer to other sections of this manual covering respective units.

Always remember a connection that is clean and tight is a good connection.

STARTER

If the engine fails to start after repeated and satisfactory operations of the starter, cause of failure cannot be attributed to the starting system, but to other functioning systems of the engine.

Starter Fails to Operate

1. Low battery. If the battery is run down, recharge or replace.
2. Loose or broken battery or ground cables. Thoroughly clean terminals and tighten or replace cables as necessary.
3. Starter solenoid contacts corroded or burned, preventing a good contact. Check and clean contacts or replace solenoid.
4. If, after making the above corrections, the starter still fails to operate, it is in need of an overhaul and must be repaired or replaced.

Starter Noisy

1. Loose mounting. Tighten cap screws or stud nuts attaching starter to clutch housing.
2. Insufficient lubrication. Lubricate as directed in Lubrication (Sec. 13 of this manual).
3. If starter is still noisy, it is in need of an overhaul and must be repaired or replaced.

Slow Cranking Speed

1. Heavy engine oil in a cold engine. Refer to Lubrication (Sec. 13 of this manual) for correct viscosity of oil.
2. Weak battery or loose cable connections. Check and correct these conditions.
3. Excessive resistance in circuit. Perform line voltage tests.
4. If the starter still operates slowly after making the above corrections, it is in need of overhaul and must be repaired or replaced.

BATTERY

Discharged

1. Loose or corroded terminals. Remove cables and clean terminals.
2. Low water in cells. Replenish water or replace battery.

TROUBLE SHOOTING

3. Shorted cells. Test and replace battery if necessary.
4. Defective generator. Test and replace if necessary.
5. Improper regulator adjustment. Test, adjust, or replace.

Overheating

Defective or improperly adjusted regulator. Test, adjust, or replace.

GENERATOR AND REGULATOR

Since the generator and regulator functions are directly related, both units must be considered when checking symptoms of failure in the generator circuit. When the ammeter shows an unsatisfactory reading, make sure the ammeter is correct before making any repairs on the generating system.

High Charging Rate With Fully Charged Battery

1. Check generator to regulator ground wire for damage or loose connections.
2. Clean and tighten all terminals and connections in generator circuit.
3. If conditions still exists, either the voltage regulator is in need of adjustment, or the generator is in need of an overhaul. In either case, replace with a new or rebuilt unit.

Low or No Charging Rate With Low Battery

1. Check all wires between generator and regulator for worn insulation or other damage. Clean and tighten all connections.
2. Loose fan belt.
3. If this does not correct the trouble, either the generator or regulator, or both, must be replaced with new or rebuilt units.

Noisy Generator

1. Loose generator mounting. Tighten.
2. If noise is still present, generator is in need of overhaul and must be repaired or replaced with a new or rebuilt unit.

LIGHTING SYSTEM

Reference to wiring diagram will show that a single circuit from battery to gang switches is common to all lights on the vehicle. At gang switches that single circuit is divided into multiple circuits, each of which is common to its particular circuit. These circuits are then taken to junction points where they are divided into individual circuits, each of which is taken to a single light. The return path of each circuit is through ground to battery. Dividing the circuits in this manner provides a convenient and logical method of locating the source of trouble. The use of a voltmeter or trouble lamp, and adherence to the following principles will aid in locating trouble in the lighting system.

1. Source of trouble common to all lights will be located in that part of the circuit common to all lights.
2. Source of trouble common to one or more --but not all--lights will be located in that part of the circuit common only to the lights affected.
3. Source of trouble at a single light will be confined to the individual circuit of the light affected.

One Light Fails

This condition is the result of an open circuit or grounded wire between the light ground and the feed wire junction. Open circuit or grounded wire may be caused by a burned out or broken light bulb filament; poor ground at light; corroded contacts or terminals; broken wire; frayed insulation; grounded or shorted terminals; or defective light switch.

Two or More Lights Fail

The cause of this condition will be located between the light switch and the individual light junction. Cause may be defective individual light switch, loose or corroded terminals, or broken wire. When two or more lights controlled by a single switch fail while others on the same switch are satisfactory, it indicates that the defect is between junction and lights.

All Lights Fail

The cause of this condition will be located between the point where the battery ground strap attaches to the frame and the light switches.

1. Discharged battery, corroded battery terminals, corroded or broken battery cable or ground strap. These points can be checked by cranking engine with starter. If cranking speed is normal, trouble lies between the battery and light switches.
2. Loose or corroded terminals; defective light switches; short circuit or ground at some point in system which causes the fuse to burn out. The only remedy is to methodically check the system until the fault is located and corrected.
3. A vehicle not in use for some time may possibly have all light bulb contacts corroded to the point where lights are inoperative. A remote possibility of failure is that all filaments may have been broken by shock.

Lights Give Insufficient Light

Excessive resistance in circuit or discharged battery. Check condition of battery, then look for loose or corroded terminals and contacts, and frayed insulation on wires.

Frequent Light Bulb Failure

High voltage, caused by a defective or improperly adjusted voltage regulator Adjust or replace.

FRONT END TROUBLE SHOOTING

The symptoms which follow in this paragraph pertain to front wheel action trouble, generally caused by incorrect front wheel alignment, steering geometry, or steering mechanism. Therefore, all trouble symptoms which may relate to the steering of the vehicle are included.

Whenever diagnosing steering difficulties, other allied factors must be checked. A symptom indicating possible trouble in the steering system may also be evidence of deficiency in other units, that is: front axle alignment, front spring suspension, tire inflation, wheel and tire mounting, wheel bearing adjustment, frame alignment, and brakes.

HARD STEERING

1. Improper adjustment of steering gear worm bearing, sector shaft lash, or drag link. Check adjustments and correct.
2. Under-inflated front tires. Inflate to manufacturer's recommendation.
3. Lack of lubrication. Lubricate as directed in Lubrication (Section 13 of this manual).
4. Bent controls in steering gear linkage. Check as directed in Front End Alignment and Steering (Sections 1A and 16 of this manual). Repair or replace defective parts.
5. Bent, broken, or worn front axle parts. Replace damaged parts.
6. Bent body longitudinal member. Check and correct if necessary.
7. Front wheel misalignment. Check as directed in Front End Alignment (Section 1A of this manual).

WANDER OR LACK OF STEERING CONTROL

1. Loose steering gear mounting, pitman arm loose, or excessive sector gear backlash. Check and adjust as necessary.
2. Loose drag link ball sockets. Tighten or replace worn parts.
3. Front wheel or axle misalignment. Check and make necessary corrections.
4. Steering system parts worn. Overhaul and replace defective parts.
5. Unequal tire pressure. Inflate both tires to tire manufacturer's recommendation.
6. Unequal camber. Check and make necessary corrections. Refer to Front End Alignment (Section 1A of this manual) for alignment instructions and data.

ROAD SHOCK TRANSMITTED TO STEERING WHEEL

1. Worn or mal-adjusted wheel bearings. Replace or adjust as necessary.
2. Excessive tire pressure. Inflate to tire manufacturer's recommendation.
3. Improper adjustment of drag link, worm bearings, or sector gear lash. Check adjustments and correct if necessary.

UNEQUAL RIGHT AND LEFT TURNING RADIUS

1. Front axle shifted on springs. Check and correct as necessary. Keep spring clip nuts tight.
2. Improperly adjusted steering knuckle stop screws.

FRONT WHEEL SHIMMY

1. Unequal tire pressure. Inflate tires equally and to tire manufacturer's recommendations.
2. Broken, bent, or worn front axle parts. Replace damaged parts.
3. Broken, bent, or worn steering mechanism parts. Replace damaged parts.
4. Improper toe-in and caster. Check and adjust. Refer to Front End Alignment (Section 1A of this manual).
5. Tire or wheel out of balance. Test and rebalance.
6. Improper steering gear or drag link adjustment. Check and adjust. Refer to Steering Gear (Section 16 of this manual).
7. Bent or improperly mounted tire or wheel.
8. Improperly adjusted or worn bearings. Adjust or replace.

VEHICLE PULLS TO ONE SIDE

1. Incorrect toe-in. Check and adjust.
2. Incorrect camber and caster. Check, adjust, or replace defective parts.
3. Defective springs. Refer to "Spring Trouble Shooting" later in this section.
4. Broken, bent, or worn front axle parts. Replace damaged parts. Refer to Front End

TROUBLE SHOOTING

Alignment and Front Axle (Sections 1A and 1B of this manual).

5. Improper alignment or broken body longitudinal member. Check and correct if necessary.

6. Incorrect axle alignment. Check and tighten spring clips and center bolt. Refer to Front End Alignment and Springs (Sections 1A and 15 of this manual).

7. Unequal tire pressure. Inflate both tires evenly and to tire manufacturer's recommendation.

8. Worn or improperly adjusted wheel bearings. Adjust or replace.

9. Front brake dragging on one side. Adjust brakes evenly or replace defective parts.

REAR AXLE TROUBLE SHOOTING

An unusual noise is usually the first indication of improper functioning of axle driving parts. Noises which seem to come from the axle may be caused by some other unit such as transmission, propeller shaft, or tires.

CONTINUOUS AXLE NOISE

1. Difficulty in the axle or unevenly worn tires.

2. To determine if noise is caused by axle or by tires, drive vehicle on soft terrain. If this stops the noise, it is being caused by the tires and not by the axle. Inflate tires to manufacturer's recommended pressure or replace if necessary.

3. If noise continues on soft terrain, it is caused by worn or improperly adjusted wheel bearings, differential gears or bearings, or by insufficient lubricant in the differential. Add lubricant, adjust wheel bearings, adjust, repair, or replace axle differential assembly.

AXLE NOISE ON DRIVE OR ON COAST ONLY

1. Differential pinion and ring gear out of adjustment or worn excessively. Adjust, repair, or replace axle differential assembly.

EXCESSIVE BACKLASH IN AXLE DRIVING PARTS

1. Loose axle shaft or drive flange cap screws or stud nuts, worn holes in flanges, or worn splines on axle shafts. Tighten cap screws or stud nuts, or replace axle shafts if necessary.

2. Differential pinion and ring gear out of adjustment or worn excessively. Adjust, repair, or replace axle differential assembly.

BRAKE TROUBLE SHOOTING

SLOW BRAKE APPLICATION

1. Low brake line pressure. Check and adjust application valve graduated pressure range.

2. Broken brake chamber diaphragm or leaking chamber. Tighten chamber flange bolts or replace diaphragm.

3. Restriction in brake lines. Remove and clean or replace.

4. Excessive chamber push-rod travel. Adjust.

5. Worn brake shoe linings. Install new linings and recondition or install new brake drums.

6. Quick release valve corroded. Remove and clean or replace.

SLOW BRAKE RELEASE

1. Quick release, or application valve corroded. Remove and clean or replace.

2. Restriction in lines preventing quick release of air pressure. Remove lines and clean or replace.

3. Intake valve in brake application valve not seating properly. Disassemble, inspect, clean, and replace defective parts.

4. Brake camshaft binding. Remove and clean.

5. Brake shoe rollers sticking or shoe frozen at anchor pin. Clean up and lubricate.

6. Lack of Lubrication. Lubricate slack adjusters, shoe rollers, camshaft supports, cam face, and shoe anchor pins as directed in Lubrication (Section 13 of this manual).

LOW AIR PRESSURE

1. Leak in air lines or fittings. Check all lines and connections with soap suds. Replace defective parts or tighten connections.

2. Leak at application valve intake valve. Remove valve and disassemble, inspect, repair, or replace defective parts.

3. Governor defective or improperly adjusted. Test and adjust, repair, or replace governor as directed in Air Compressor and Governor (Sec. 4C of this manual).

4. Defective compressor unloading valve operation. Check clearance between valve stems and adjusting screws. Remove compressor cylinder head and clean valves and stems. Regrind or replace valves if necessary. Check tension

of valve springs. Refer to Air Compressor and Governor (Sec. 4C of this manual).

5. Defective compressor discharge valve operation. Clean, inspect, and regrind or replace valve discs and seats if necessary. Check tension of valve springs. Refer to Air Compressor and Governor (Sec. 4C of this manual).

6. Compressor discharge line choked with carbon. Remove and clean.

SLOW PRESSURE BUILD UP

1. Check all items previously listed under "Low Air Pressure."

2. Worn compressor parts necessitating complete overhaul of compressor. Refer to Air Compressor and Governor (Sec. 4C of this manual).

RAPID LOSS OF PRESSURE WHEN ENGINE IS STOPPED

1. Air leaks in system. Check all air line connections for leakage, using soap suds. Also check for leakage at application, and quick release valve exhaust ports. Make necessary repairs or replacements.

2. Defective compressor discharge valve operation. Clean, grind, or replace discharge valve discs and seats.

EXCESSIVE AIR PRESSURE

1. Defective unloading diaphragm. Replace diaphragm.

2. Excessive clearance between unloading valve stems and adjusting screws. Adjust as directed in Air Compressor and Governor (Sec. 4C of this manual).

3. Governor improperly adjusted or defective. Adjust, repair, or replace governor as directed in Air Compressor and Governor (Sec. 4C of this manual).

4. Restricted unloading chamber to governor air line. Remove line and clean out or replace.

NOISY BRAKES

1. Dirty, worn, or loose brake linings, or distorted brake shoes. Inspect and replace damaged or worn parts.

2. Scored or damaged brake drums. Inspect, repair, or replace as directed in Air Brakes (Sec. 4B of this manual).

ONE BRAKE DRAGS

1. Improper adjustment. Adjust.

2. Corroded or bent brake mechanism. Weak or broken brake shoe return spring. Clean, inspect, and replace defective parts.

3. Restricted brake line. Remove, inspect, and correct as necessary.

4. Inoperative chamber due to bent push rod. Replace damaged parts.

5. Wheel bearings out of adjustment. Adjust.

CLUTCH TROUBLE SHOOTING

The clutch is designed for maximum efficiency and long life, and with reasonable care, no operating difficulty should be encountered. Natural wear will occur, however, and must be compensated for by adjusting when required.

CLUTCH SLIPPING

1. Improper adjustment (no pedal free-travel). Adjust pedal free-travel.

2. Worn facings, grease on facings, clutch disc hub binding on clutch shaft, or insufficient spring tension. Replace defective parts or complete clutch assembly.

3. Pressure plate sticking. Excessive clearance between driving block and pressure plate lugs. Refer to Clutch (Sec. 5 of this manual) for correction and clearances.

CLUTCH GRABBING AND CHATTERING

1. Improper operation. Correct poor driving practices.

2. Improper adjustment. Adjust pedal free-travel. Refer to Clutch (Sec. 5 of this manual).

3. Loose engine mounting bolts. Inspect and tighten if necessary.

4. Grease on facings, worn splines on clutch shaft or in disc hub, facing loose on disc, or pressure plate scored or rough. Replace defective parts or complete clutch assembly. Inspect for worn splines on clutch shaft and replace if this condition is found.

IMPROPER RELEASE

1. Improper adjustment. Adjust.

2. Pressure plate or driven disc worn, warped, or distorted. Inspect, repair, or replace defective parts.

3. Weak or broken return springs. Replace.

4. Worn release bearing. Install new bearing and adjust pedal free travel.

5. Controls binding. Inspect and correct cause.

TROUBLE SHOOTING

SPRINGS TROUBLE SHOOTING

HARD RIDING

1. Overloaded or load unevenly distributed. Always distribute load evenly and do not overload.
2. Shackle pins and bracket bolts "frozen" or broken due to insufficient lubrication. Lubricate as specified in Lubrication (Sec. 13 of this manual). Remove and clean or replace defective shackle pins or bracket bolts.
3. Axle shifted due to loose spring clips. Relocate and tighten spring clip nuts.

OVER FLEXIBLE

1. Excessive lubrication of spring leaves. Lubricate only at intervals specified on Lubrication Chart.
2. Broken spring leaf rebound clips. Replace broken parts.
3. Shock absorbers not functioning. Lack of fluid, worn or broken parts. Keep filled to level plug or disassemble and inspect for parts failure.

EXCESSIVE NOISE

1. Worn shackle bolts and spring eye bolts or bushings. Check and replace worn parts.
2. Loose spring clip nuts. Relocate axle if shifted and tighten spring clip nuts.

SPRING LEAF FAILURE

1. Overloading vehicle or driving at excessive speed over rough terrain. Reduce speed and do not overload.
2. Loose rebound clips. Keep clips tight.
3. Frozen shackle pins and bracket pins due to lack of lubrication. Remove shackle and bracket pins and clean or replace as necessary. Lubricate as directed in Lubrication (Sec. 13 of this manual).
4. Grabbing brake. Refer to "Brake Trouble Shooting" previously described in this section for causes and remedies.

TRANSMISSION TROUBLE SHOOTING

Symptoms indicating trouble in transmission is sometimes caused by another assembly, such as axle, propeller shaft, universal joint, or clutch. Therefore, before removing the transmission to locate the trouble, always check the possibility that trouble may exist in other units.

NOISY

Before beginning actual operations to eliminate noise attributed to transmission, make sure that the noise is not coming from another unit in vehicle, such as propeller shafts or rear axle. Also bear in mind that a limited amount of transmission gear "noise" is normal, except when the unit is in direct drive. Following are some of the causes of noise with suggested remedies.

1. Worn or damaged parts. Replace parts as necessary or overhaul the assembly.
2. Improper or insufficient lubricant. Change or add lubricant as directed in Lubrication (Sec. 13 of this manual).
3. Misalignment of transmission with clutch housing. Tighten transmission mounting bolts if not tight, otherwise determine and correct cause of misalignment.

SHIFTING DIFFICULTIES

1. Clutch release linkage improperly adjusted. Adjust or repair clutch release mechanism as directed in Clutch (Sec. 5 of this manual).
2. Binding in transmission control cover. Remove and inspect control mechanism for bent or worn parts. Replace damaged parts.
3. Bent or binding of control rods at guides. Check and make necessary corrections.
4. Incorrect driving practices. Coordinate the use of gearshift lever with use of clutch and accelerator. Refer to Operation (Sec. O of this manual).
5. Too heavy gear lubricant. Refer to "Lubrication Chart" for recommended type of lubricant and viscosity.
6. Reverse solenoid linkage out of adjustment will contribute to difficulty when shifting into reverse. Adjust linkage as directed in Mechanical Transmission (Sec. 17 of this manual).

JUMPING OUT OF GEAR

1. Improper shifting. Completely engage mating gears before releasing clutch. Move gearshift lever until poppet engages notch in shift rod.
2. Excessive end play due to wear in one or more of following parts: Shift forks, fork grooves in sliding clutches, thrust washers, mainshaft or countershaft bearings, gear bearings or bushings. Replace worn parts.
3. Broken snap rings permitting gears or shafts to move endwise. Install new snap rings and shims (if required).
4. Shift forks bent or loose on shift rods. Check shift forks for bends and correct offset. Tighten fork retaining screw.
5. Loose propeller shaft companion flange nut. Tighten nut.
6. Poppet springs weak or broken. Replace.

LUBRICANT LEAKS

1. Lubricant level too high. Keep level at filler plug level. Refer to Lubrication (Sec. 13 of this manual).
2. Worn oil seal. Replace oil seal assembly.
3. Main drive gear bearing retaining screws loose. Tighten screws.
4. Cover plate screws loose or gaskets defective. Tighten screws or replace gaskets.
5. Bearing retainers (caps) loose. Tighten screws firmly.
6. Transmission case cracked or broken. Replace transmission case. No repair is recommended.

PROPELLER SHAFT TROUBLE SHOOTING

EXCESSIVE NOISE OR VIBRATION

1. Lack of lubrication. Lubricate as directed in Lubrication (Sec. 13 of this manual).
2. If propeller shafts are not assembled with universal joints in the same plane, vibration will result. Check for this condition and if found, disconnect propeller shafts and place universal joints in same plane.
3. Worn universal joint bearings or journals, or a sprung propeller shaft will cause vibration and noise. Check for these conditions and replace propeller shaft assembly if necessary.
4. Any mechanical movement has vibration periods, which do not result in noise until they tune in with some other part or unit. In this connection, loose or broken body panels, etc., should be checked as the source of noise if the above remedies do not correct the condition.

WHEELS, HUBS, AND TIRES TROUBLE SHOOTING

When localizing wheel and tire trouble symptoms, consideration must also be taken of various related systems such as brakes, wheel alignment, and steering gear system. Deficiencies in these systems or units will affect performance of wheels, tires, and hub bearings.

EXCESSIVE OR UNEVEN TIRE WEAR

1. Unequal pressures in the tires. Inflate all tires to tire manufacturer's recommendations.
2. Front wheel misalignment. Check front wheel alignment and make necessary corrections.
3. Bent wheels or damaged wheel bearings. Replace wheels or bearings as necessary.
4. Broken, bent, or worn front axle parts. Replace damaged parts. Refer to Front End Alignment and Front Axle (Sec. 1A and 1B of this manual).
5. Improper steering geometry. Refer to Front End Alignment (Sec. 1A of this manual).

WHEELS POUNDING

Hub bearings damaged or in need of adjustment. A bent wheel will also cause this condition. Replace or adjust hub bearings, or replace wheel.

SHIMMY

Conditions causing wheel shimmy are previously listed under "Front End" in this section.